CAMBRIDGE TECHNICALS IN ENGINEERING

LEVEL 3 UNIT 2 - Science for Engineering

RESOURCES LINK

March 2015

Introduction

Resources Link is an e-resource, provided by OCR, for teachers of OCR qualifications. It provides descriptions of, and links to, a variety of independent teaching and learning resources that you may find helpful.

In Resources Link you will find details of independent resources, many of which are free: where this is the case this has been indicated.

If you know of other resources you would like to see included here, or discover broken links, please let us know. We would also like to hear from you if have any feedback about your use of these, or other, OCR resources. Please contact us at resourcesfeedback@ocr.org.uk.

We leave it to you, as a professional educator, to decide if any of these resources are right for you and your learners, and how best to use them.

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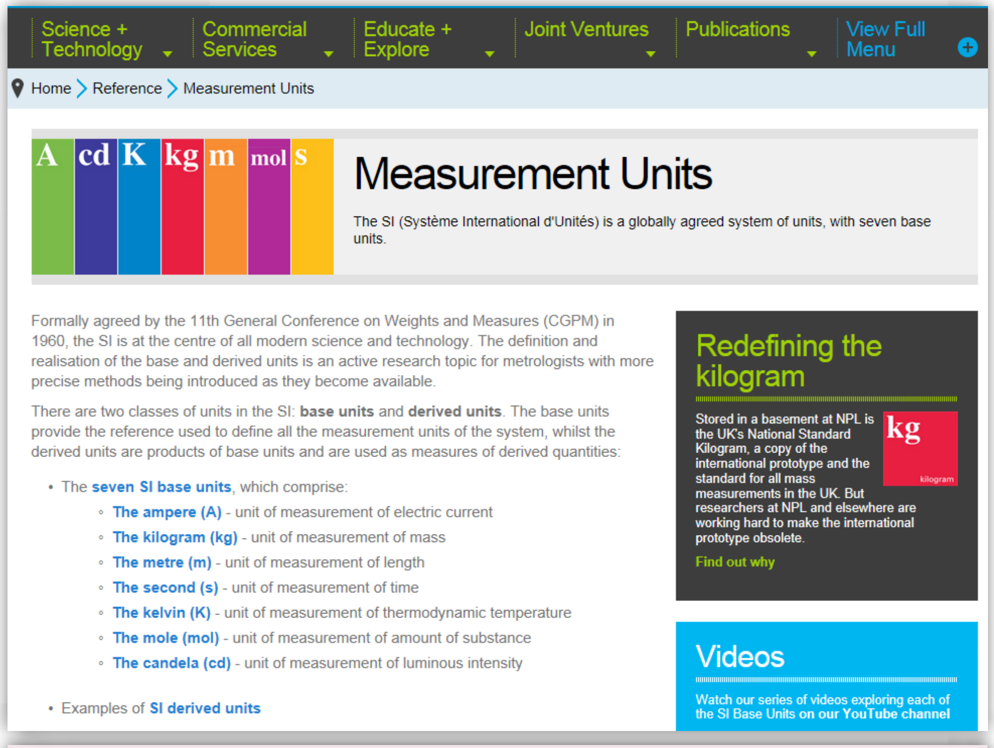
Measurement units – SI Units



http://www.npl.co.uk/reference/measurement-units/

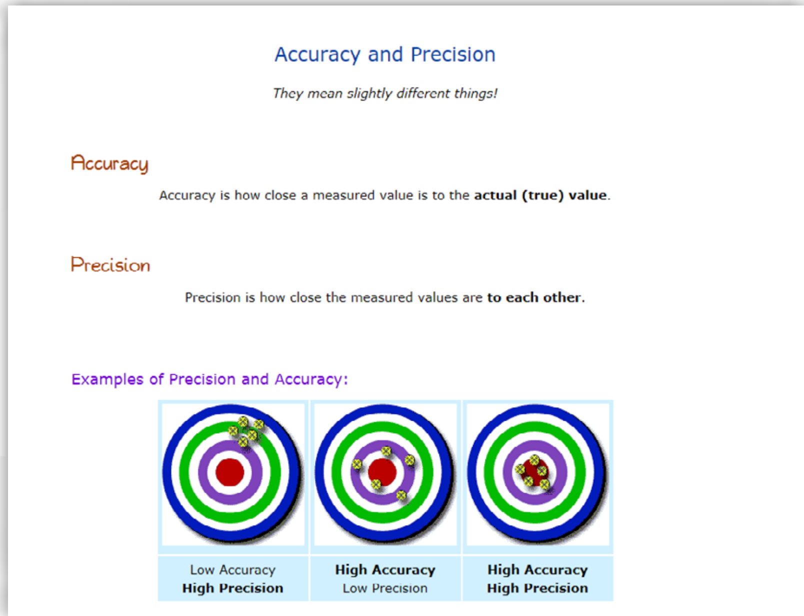
Description:
National Physical Laboratory (NPL) definition of the seven base SI units. Also defines SI derived quantities. Includes links explaining each of the units in detail – including videos.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Web page

Accuracy, precision and Bias



http://www.mathsisfun.com/accuracy-precision.html

Description:
Explanation of the terms accuracy, precision and bias with examples.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Web page

Why calibrate an instrument?

Why Calibrate an Instrument?

Edward Simpson posted on July 31, 2013 | Comment | 15613 views

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Calibrating an instrument involves comparing the measurements of two instruments; one with a known magnitude or correctness (standard device), against which you measure the unit under test.

Calibration has been defined by the International Bureau of Weights and Measures as an "Operation that, under specified conditions, in the first step, establishes a

http://www.engineering.com/ElectronicsDesign/ElectronicsDesignArticles/ArticleID/6098/Why-Calibrate-an-Instrument.aspx

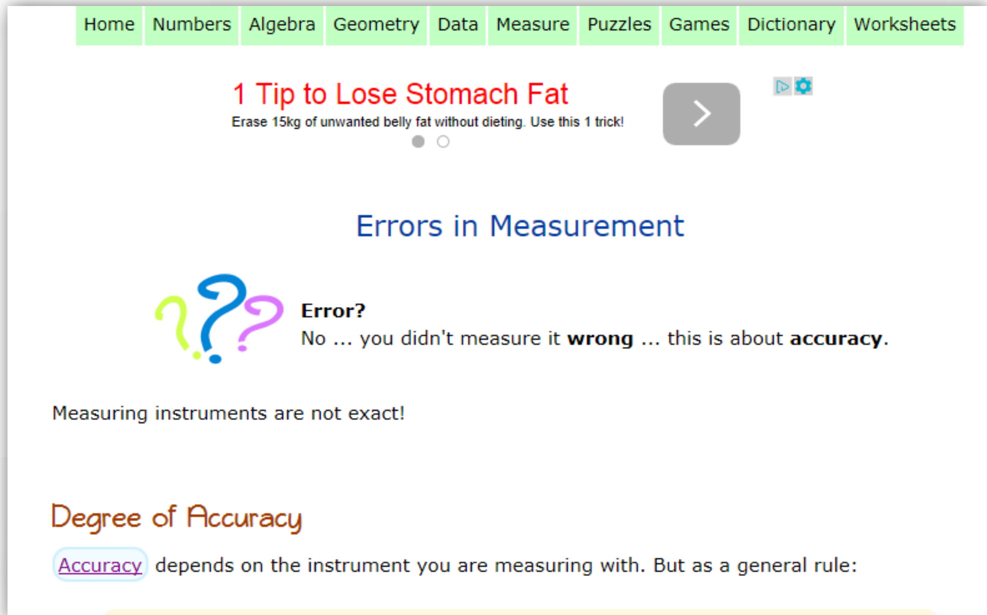
Description:
Article provides an international definition of calibration, and explains why calibration is important.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Web page

Errors in Measurement



http://www.mathsisfun.com/measure/error-measurement.html

Description:
Explanation with worked examples of errors in measurement including absolute, relative and percentage error.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Web page

Standard Deviation

https://www.youtube.com/watch?v=09kiX3p5Vek

Description:
A YouTube video explaining standard deviation. Includes worked examples and student examples to calculate.

Supports:
OCR Cambridge Technicals in Engineering Level 3
Unit 2

Cost:
Free

Format:
Youtube video

Standard Error

http://www.youtube.com/watch?v=BwYj69LAQOI

Description:
A YouTube video explaining standard error. Follows on from video on standard deviation. Includes worked examples and student examples to calculate.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Youtube video

Beginners Guide to Measurement in Mechanical Engineering

http://www.npl.co.uk/upload/pdf/beg-guide-measurement-mech-eng.pdf

Description:
A PDF guide including case studies produced by NPL and the Institution of Mechanical Engineers (IMechE). Includes further useful illustration of accuracy, precision, relative and absolute error. Also discusses calibration.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Free PDF

Beginner's Guide to Measurement in Electronic and Electrical Engineering

http://www.npl.co.uk/upload/pdf/gpg-132-beg-guide-measurement-electronic-electrical-eng.pdf

Description:
A PDF guide including case studies produced by NPL and the Institution of Engineering and Technology (IET). Includes further useful illustration of accuracy, precision, relative and absolute error. Also discusses calibration.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Free PDF

Introduction to the Language of Kinematics

Introduction to the Language of Kinematics

Introduction
Scalars and Vectors
Distance and Displacement
Speed and Velocity
Acceleration

A typical physics course concerns itself with a variety of broad topics. One such topic is **mechanics** - the study o the motion of objects. The first six units of The Physics Classroom tutorial will involve an investigation into the physics of motion. As we focus on the language, principles, and laws that describe and explain the motion of objects, your efforts should center on internalizing the meaning of the information. Avoid memorizing the information; and avoid abstracting the information from the physical world that it describes and explains. Rather, contemplate the information, thinking about its meaning and its applications.

Kinematics is the science of describing the motion of objects using words, diagrams, numbers, graphs, and equations. Kinematics is a branch of mechanics. The goal of any study of kinematics is to develop sophisticated mental models that serve to describe (and ultimately, explain) the motion of real-world objects.

In this lesson, we will investigate the words used to describe the motion of objects. That is, we will focus on the *language* of kinematics. The hope is to gain a comfortable foundation with the language that is used throughout study of mechanics. We will study such terms as scalars, vectors, distance, displacement, speed, velocity and acceleration. These words are used with regularity to describe the motion of objects. Your goal should be to

http://www.physicsclassroom.com/class/1DKin/Lesson-1/Introduction

Description:
A good introduction to kinematics including scalars and vectors, displacement, speed, velocity, acceleration work energy and power. Includes animations and practice questions.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Web page

The Kinematics Equations

The Kinematic Equations

Kinematic Equations
Kinematic Equations and Problem-Solving
Kinematic Equations and Free Fall
Sample Problems and Solutions
Kinematic Equations and Graphs

The goal of this first unit of The Physics Classroom has been to investigate the variety of means by which the motion of objects can be described. The variety of representations that we have investigated includes verbal representations, pictorial representations, numerical representations, and graphical representations (position-time graphs and velocity-time graphs). In Lesson 6, we will investigate the use of equations to describe and represent the motion of objects. These equations are known as **kinematic equations**.

There are a variety of quantities associated with the motion of objects - displacement (and distance), velocity (and speed), acceleration, and time. Knowledge of each of these quantities provides descriptive information about an object's motion. For example, if a car is known to move with a constant velocity of 22.0 m/s, North for 12.0 seconds for a northward displacement of 264 meters, then the motion of the car is fully described. And if a second car is known to accelerate from a rest position with an eastward acceleration of 3.0 m/s^2 for a time of 8.0 seconds, providing a final velocity of 24 m/s, East and an eastward displacement of 96 meters, then the motion of this car is fully described. These two statements provide a complete description of the motion of an object. However, such completeness is not always known. It is often the case that only a few parameters of an object's motion are known, while the rest are unknown. For example as you approach the stoplight, you might know that your car has a velocity of 22 m/s, East and is capable of a skidding acceleration of 8.0 m/s^2, West. However you do not know the displacement that your car would experience if you were to slam on your brakes and skid to a stop; and you do not

http://www.physics.ryerson.ca/sites/default/files/u11/guidelines/L5_RLC_Circuits.pdf

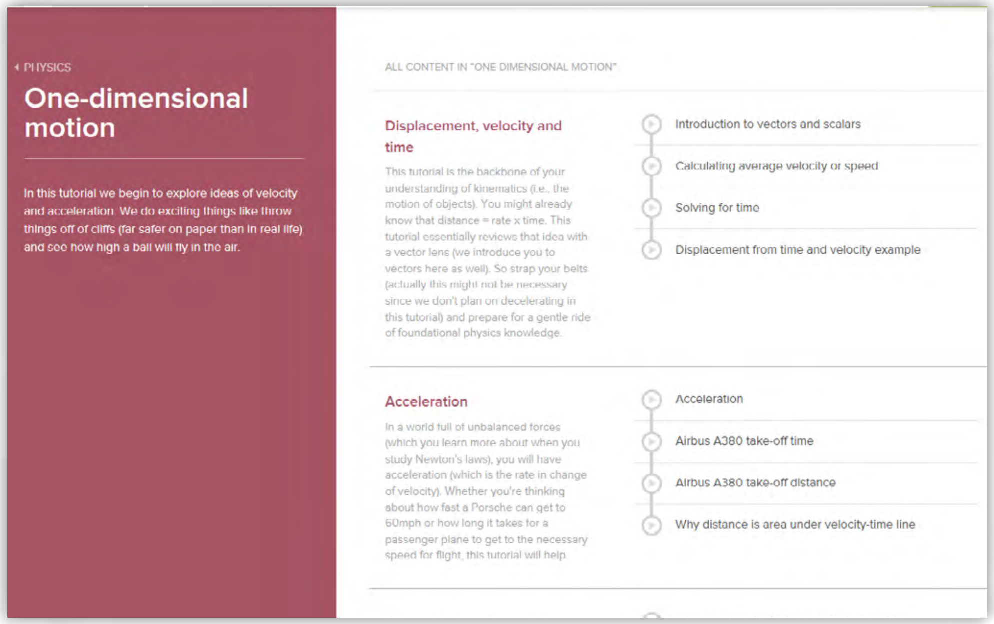
Description:
Complete explanation with examples of the equations of motion.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Web page

One-dimensional motion



https://www.khanacademy.org/science/physics/one-dimensional-motion

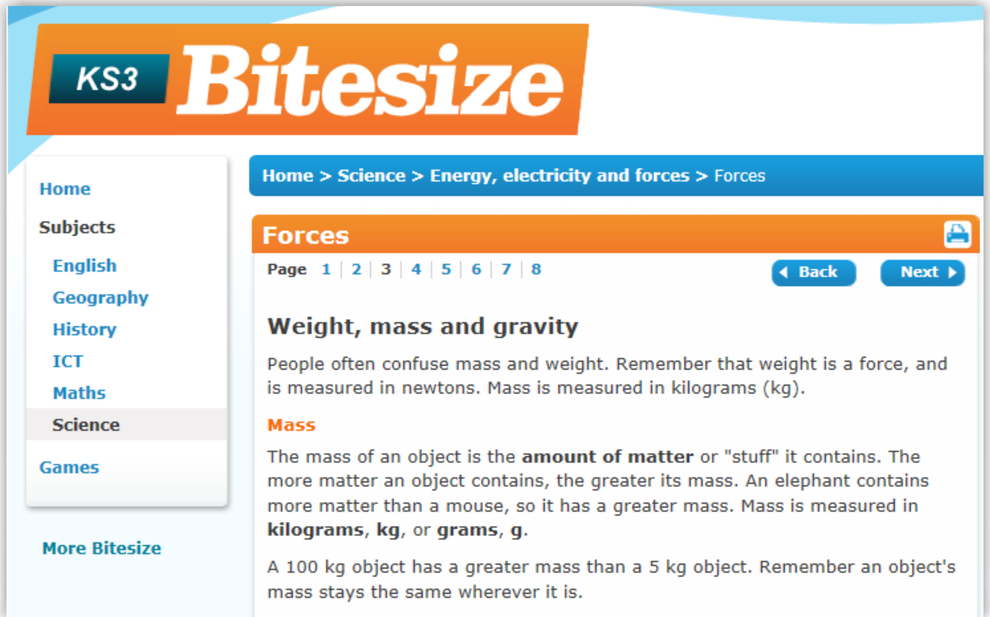
Description:
Complete set of video resources explaining motion including scalars and vectors, displacement, velocity, acceleration and kinematics.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Web page with video resources

Weight, mass and gravity



http://www.bbc.co.uk/bitesize/ks3/science/energy_electricity_forces/forces/revision/3/

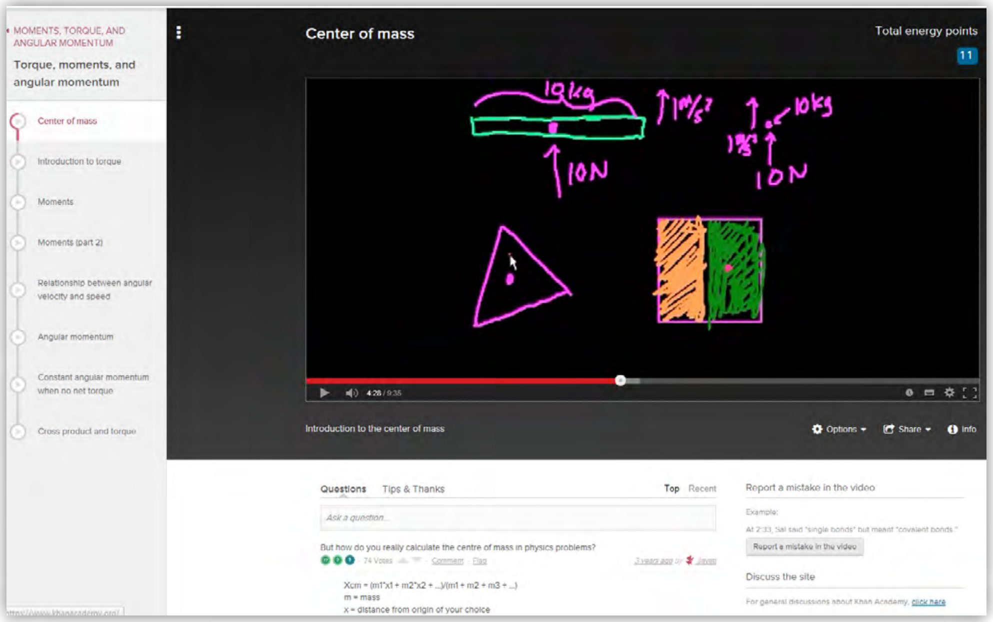
Description:
Useful recap on the connection between weight, mass and gravity.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Web page

Torque, Moments and Centre of Mass



https://www.khanacademy.org/science/physics/torque-angular-momentum/torque-tutorial/v/center-of-mass

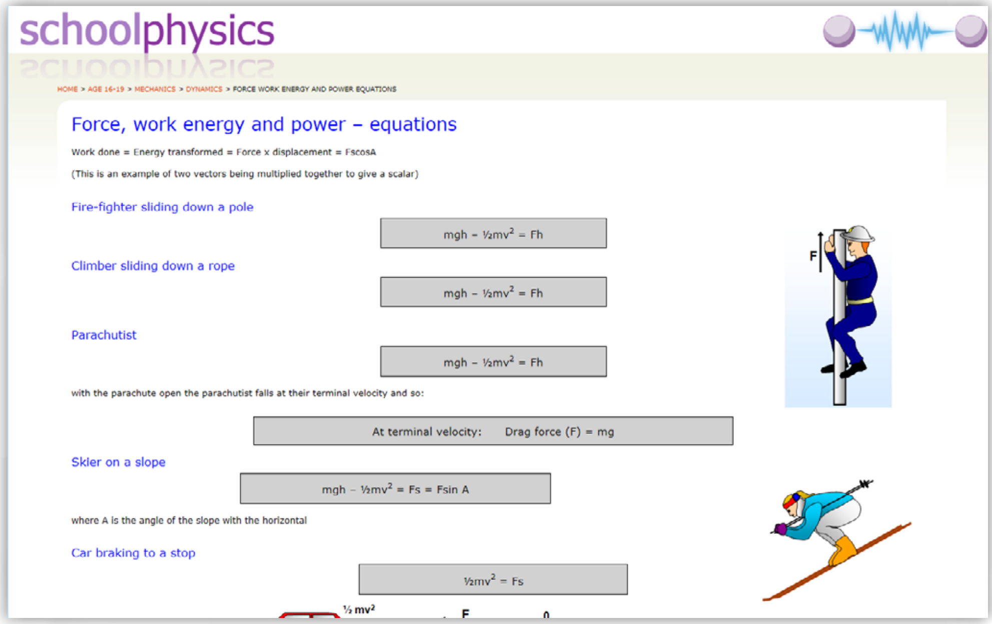
Description:
Complete set of video resources covering centre of gravity and rotation – including torque.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Web page with video resources

Force, work energy and power



http://www.schoolphysics.co.uk/age16-19/Mechanics/Dynamics/text/Force_Work_Energy_Power_equations/index.html

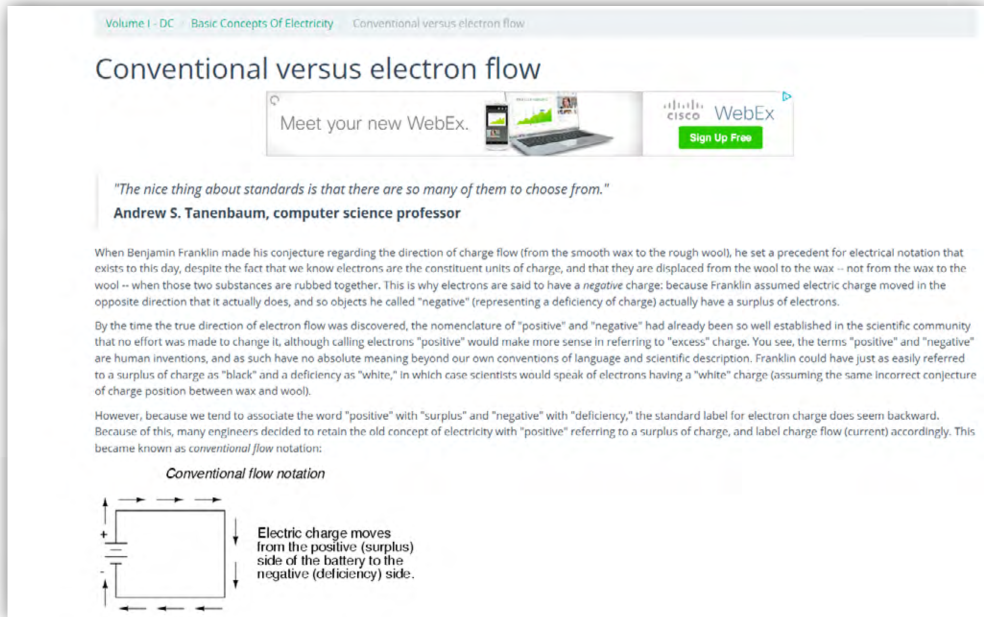
Description:
Summary of equations relating to force, work energy and power.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Web page

Conventional versus electron flow


Volume I - DC / Basic Concepts Of Electricity / Conventional versus electron flow

Conventional versus electron flow

> *"The nice thing about standards is that there are so many of them to choose from."*
> **Andrew S. Tanenbaum, computer science professor**

When Benjamin Franklin made his conjecture regarding the direction of charge flow (from the smooth wax to the rough wool), he set a precedent for electrical notation that exists to this day, despite the fact that we know electrons are the constituent units of charge, and that they are displaced from the wool to the wax -- not from the wax to the wool -- when those two substances are rubbed together. This is why electrons are said to have a *negative* charge: because Franklin assumed electric charge moved in the opposite direction that it actually does, and so objects he called "negative" (representing a deficiency of charge) actually have a surplus of electrons.

By the time the true direction of electron flow was discovered, the nomenclature of "positive" and "negative" had already been so well established in the scientific community that no effort was made to change it, although calling electrons "positive" would make more sense in referring to "excess" charge. You see, the terms "positive" and "negative" are human inventions, and as such have no absolute meaning beyond our own conventions of language and scientific description. Franklin could have just as easily referred to a surplus of charge as "black" and a deficiency as "white," in which case scientists would speak of electrons having a "white" charge (assuming the same incorrect conjecture of charge position between wax and wool).

However, because we tend to associate the word "positive" with "surplus" and "negative" with "deficiency," the standard label for electron charge does seem backward. Because of this, many engineers decided to retain the old concept of electricity with "positive" referring to a surplus of charge, and label charge flow (current) accordingly. This became known as *conventional flow* notation:

http://www.allaboutcircuits.com/vol_1/chpt_1/7.html

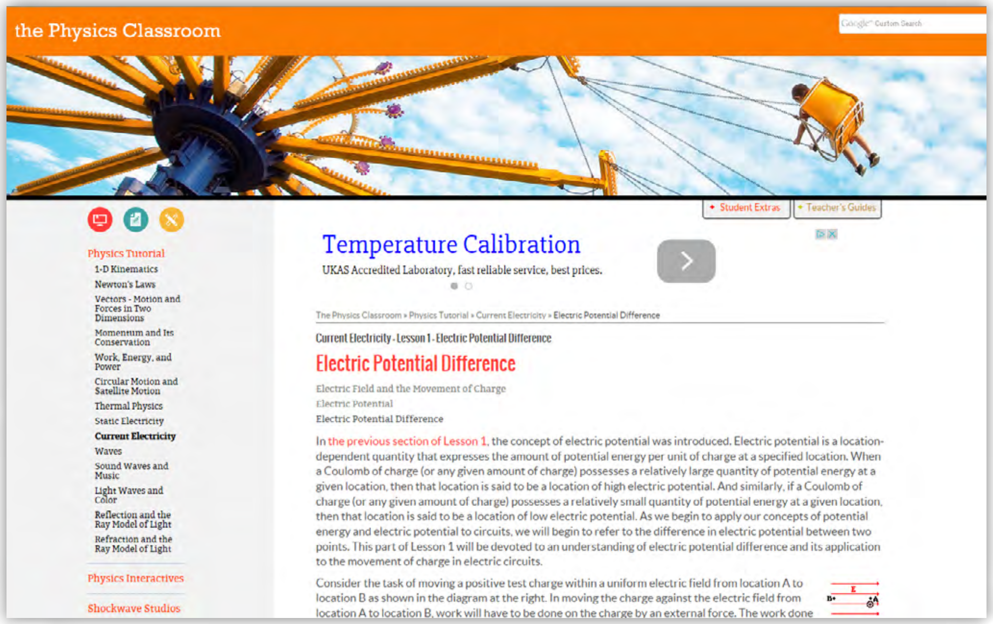
Description:
An article discussing conventional and electron flow in electric circuits. Also discusses circuits containing lamps and diodes. Has links to further articles considering voltage, current and resistance.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Web page

Electric potential difference



http://www.physicsclassroom.com/class/circuits/Lesson-1/Electric-Potential-Difference

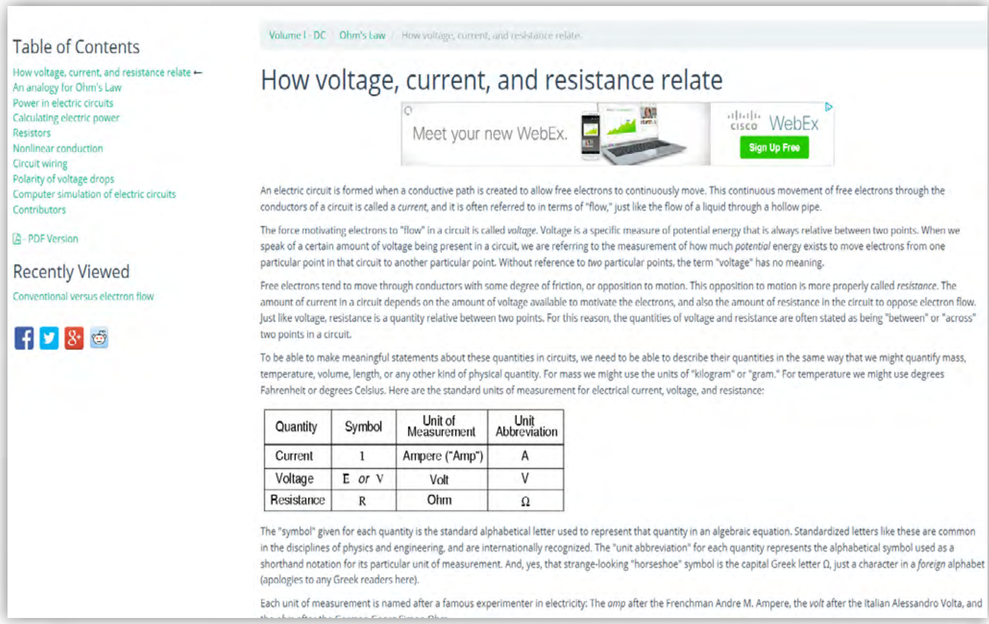
Description:
Explanation with diagrams of potential difference. Links to other a web pages explaining potential and charge (Coulombs).

Supports:
OCR Cambridge Technicals in Engineering Level 3
Unit 2

Cost:
Free

Format:
Web page

How voltage, current and resistance relate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PDF Version

Recently Viewed

Conventional versus electron flow

Volume I - DC / Ohm's Law / How voltage, current, and resistance relate

How voltage, current, and resistance relate

An electric circuit is formed when a conductive path is created to allow free electrons to continuously move. This continuous movement of free electrons through the conductors of a circuit is called a *current*, and it is often referred to in terms of "flow," just like the flow of a liquid through a hollow pipe.

The force motivating electrons to "flow" in a circuit is called *voltage*. Voltage is a specific measure of potential energy that is always relative between two points. When we speak of a certain amount of voltage being present in a circuit, we are referring to the measurement of how much *potential* energy exists to move electrons from one particular point in that circuit to another particular point. Without reference to *two* particular points, the term "voltage" has no meaning.

Free electrons tend to move through conductors with some degree of friction, or opposition to motion. This opposition to motion is more properly called *resistance*. The amount of current in a circuit depends on the amount of voltage available to motivate the electrons, and also the amount of resistance in the circuit to oppose electron flow. Just like voltage, resistance is a quantity relative between two points. For this reason, the quantities of voltage and resistance are often stated as being "between" or "across" two points in a circuit.

To be able to make meaningful statements about these quantities in circuits, we need to be able to describe their quantities in the same way that we might quantify mass, temperature, volume, length, or any other kind of physical quantity. For mass we might use the units of "kilogram" or "gram." For temperature we might use degrees Fahrenheit or degrees Celsius. Here are the standard units of measurement for electrical current, voltage, and resistance:

Quantity	Symbol	Unit of Measurement	Unit Abbreviation
Current	I	Ampere ("Amp")	A
Voltage	E *or* V	Volt	V
Resistance	R	Ohm	Ω

The "symbol" given for each quantity is the standard alphabetical letter used to represent that quantity in an algebraic equation. Standardized letters like these are common in the disciplines of physics and engineering, and are internationally recognized. The "unit abbreviation" for each quantity represents the alphabetical symbol used as a shorthand notation for its particular unit of measurement. And, yes, that strange-looking "horseshoe" symbol is the capital Greek letter Ω, just a character in a *foreign* alphabet (apologies to any Greek readers here).

Each unit of measurement is named after a famous experimenter in electricity: The *amp* after the Frenchman Andre M. Ampere, the *volt* after the Italian Alessandro Volta, and

http://www.allaboutcircuits.com/vol_1/chpt_2/1.html

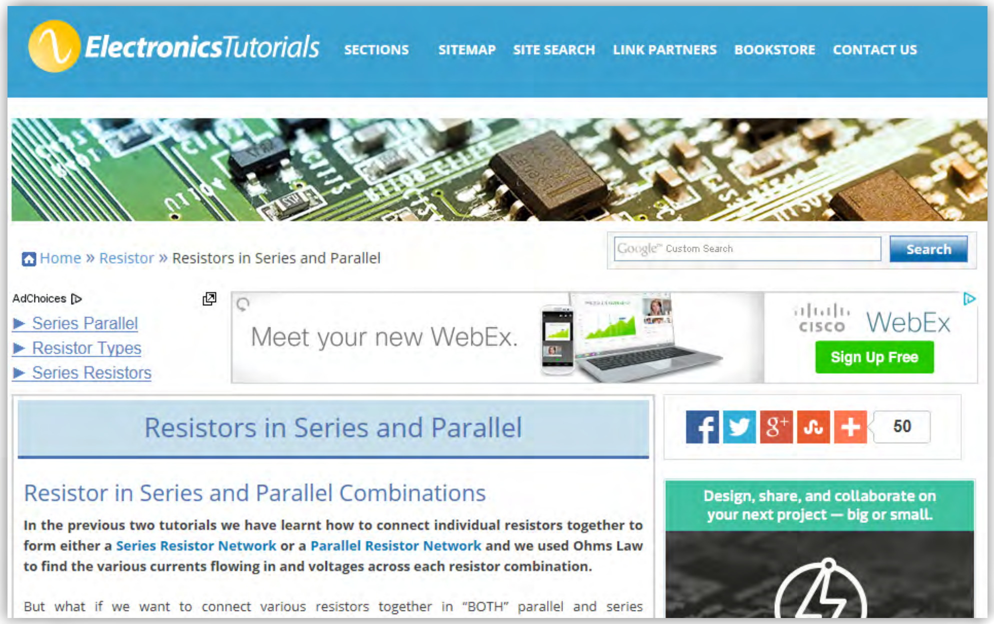
Description:
Series of web pages looking at the relationship between voltage, current and resistance. Includes worked examples and worksheets. Includes power calculations.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Web page

Resistors in Series and Parallel



http://www.electronics-tutorials.ws/resistor/res_5.html

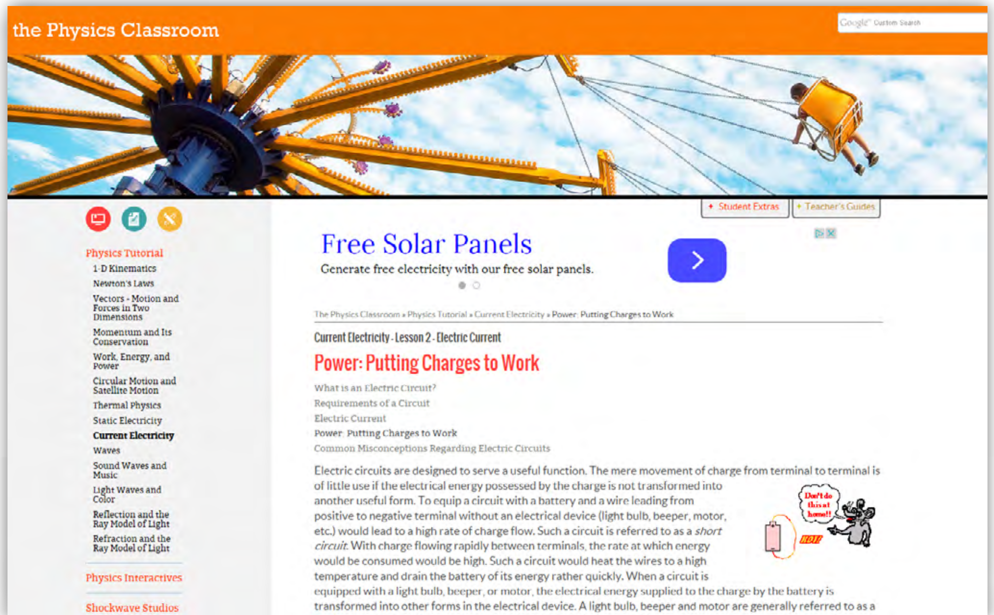
Description:
Explanation of how to calculate total resistance for circuits containing series and parallel resistors.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Web page

Energy and Power



http://www.physicsclassroom.com/Class/circuits/u9l2d.cfm

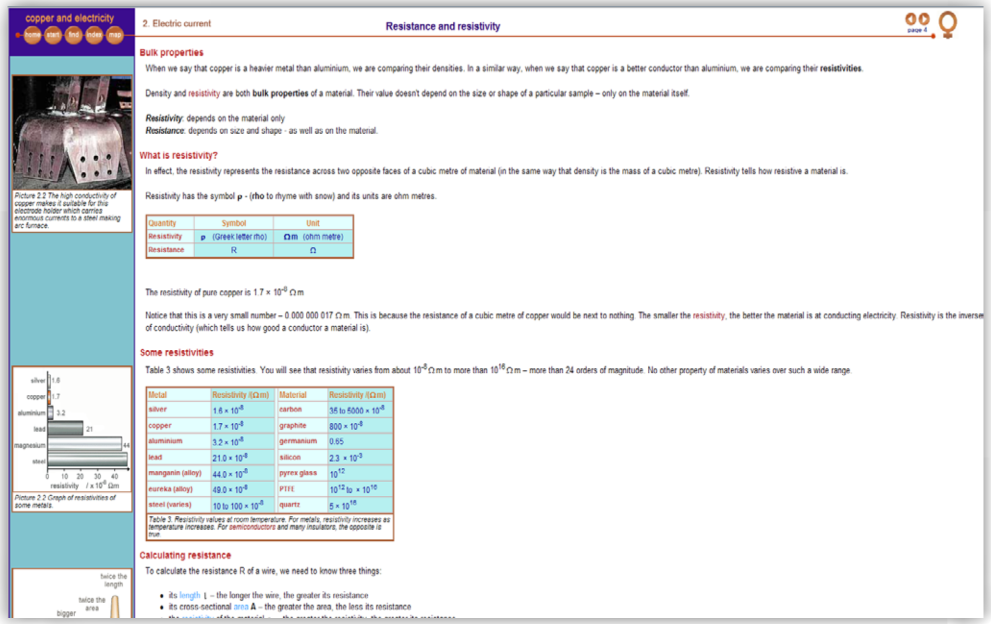
Description:
Series of linked articles explaining (with worked examples) the relationship of energy with power. Includes example problems for learners to calculate.

Supports:
OCR Cambridge Technicals in Engineering Level 3
Unit 2

Cost:
Free

Format:
Web page

Resistance and Resistivity



copper and electricity

home start find index map

2. Electric current

Resistance and resistivity

page 4

Picture 2.2 The high conductivity of copper makes it suitable for this electrode holder which carries enormous currents to a steel making arc furnace.

Bulk properties

When we say that copper is a heavier metal than aluminium, we are comparing their densities. In a similar way, when we say that copper is a better conductor than aluminium, we are comparing their **resistivities**.

Density and resistivity are both **bulk properties** of a material. Their value doesn't depend on the size or shape of a particular sample – only on the material itself.

Resistivity: depends on the material only
Resistance: depends on size and shape - as well as on the material.

What is resistivity?

In effect, the resistivity represents the resistance across two opposite faces of a cubic metre of material (in the same way that density is the mass of a cubic metre). Resistivity tells how resistive a material is.

Resistivity has the symbol **ρ** - (**rho** to rhyme with snow) and its units are ohm metres.

Quantity	Symbol	Unit
Resistivity	ρ (Greek letter rho)	Ωm (ohm metre)
Resistance	R	Ω

The resistivity of pure copper is 1.7×10^{-8} Ω m

Notice that this is a very small number – 0.000 000 017 Ω m. This is because the resistance of a cubic metre of copper would be next to nothing. The smaller the resistivity, the better the material is at conducting electricity. Resistivity is the inverse of conductivity (which tells us how good a conductor a material is).

Some resistivities

Table 3 shows some resistivities. You will see that resistivity varies from about 10^{-8} Ω m to more than 10^{16} Ω m – more than 24 orders of magnitude. No other property of materials varies over such a wide range.

Picture 2.2 Graph of resistivities of some metals.

Metal	Resistivity /(Ωm)	Material	Resistivity /(Ωm)
silver	1.6×10^{-8}	carbon	35 to 5000×10^{-8}
copper	1.7×10^{-8}	graphite	800×10^{-8}
aluminium	3.2×10^{-8}	germanium	0.65
lead	21.0×10^{-8}	silicon	2.3×10^{-3}
manganin (alloy)	44.0×10^{-8}	pyrex glass	10^{12}
eureka (alloy)	49.0×10^{-8}	PTFE	10^{12} to $\times 10^{16}$
steel (varies)	10 to 100×10^{-8}	quartz	5×10^{16}

Table 3. Resistivity values at room temperature. For metals, resistivity increases as temperature increases. For semiconductors and many insulators, the opposite is true.

Calculating resistance

To calculate the resistance R of a wire, we need to know three things:

- its length L – the longer the wire, the greater its resistance
- its cross-sectional area A – the greater the area, the less its resistance

http://resources.schoolscience.co.uk/CDA/16plus/copelech2pg1.html

Description:
An explanation with calculations of the relationship between resistance and resistivity.

Supports:
OCR Cambridge Technicals in Engineering Level 3
Unit 2

Cost:
Free

Format:
Web page

Resistance variation with temperature

http://www.electrical4u.com/electrical-resistance-and-laws-of-resistance/

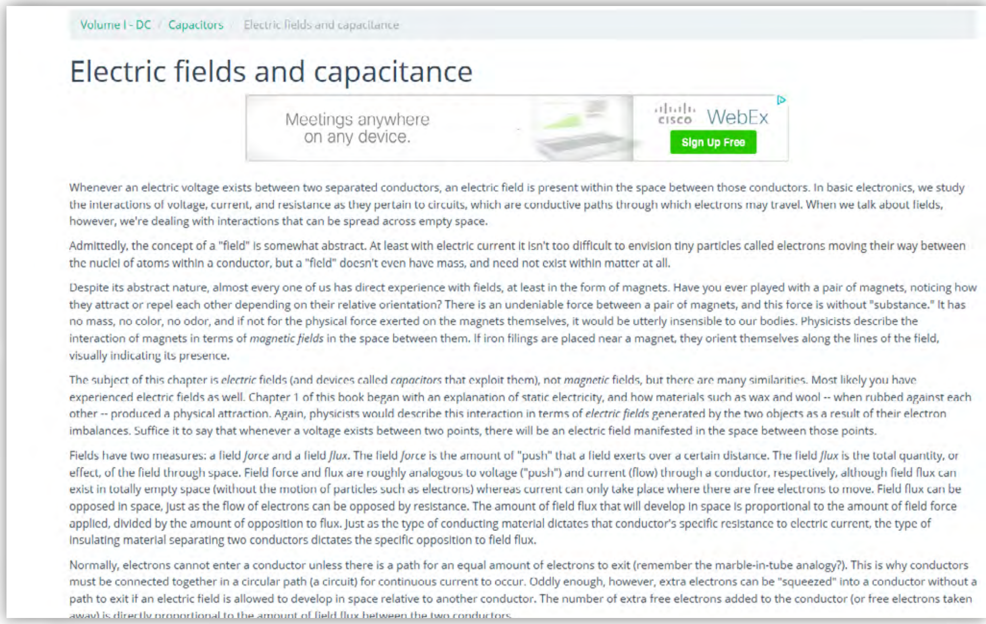
Description:
An explanation of resistivity, resistance and how resistance of a material varies with temperature. Includes videos.

Supports:
OCR Cambridge Technicals in Engineering Level 3
Unit 2

Cost:
Free

Format:
Web Page

Electric field and capacitors



Volume I - DC / Capacitors / Electric fields and capacitance

Electric fields and capacitance

Whenever an electric voltage exists between two separated conductors, an electric field is present within the space between those conductors. In basic electronics, we study the interactions of voltage, current, and resistance as they pertain to circuits, which are conductive paths through which electrons may travel. When we talk about fields, however, we're dealing with interactions that can be spread across empty space.

Admittedly, the concept of a "field" is somewhat abstract. At least with electric current it isn't too difficult to envision tiny particles called electrons moving their way between the nuclei of atoms within a conductor, but a "field" doesn't even have mass, and need not exist within matter at all.

Despite its abstract nature, almost every one of us has direct experience with fields, at least in the form of magnets. Have you ever played with a pair of magnets, noticing how they attract or repel each other depending on their relative orientation? There is an undeniable force between a pair of magnets, and this force is without "substance." It has no mass, no color, no odor, and if not for the physical force exerted on the magnets themselves, it would be utterly insensible to our bodies. Physicists describe the interaction of magnets in terms of *magnetic fields* in the space between them. If iron filings are placed near a magnet, they orient themselves along the lines of the field, visually indicating its presence.

The subject of this chapter is *electric* fields (and devices called *capacitors* that exploit them), not *magnetic* fields, but there are many similarities. Most likely you have experienced electric fields as well. Chapter 1 of this book began with an explanation of static electricity, and how materials such as wax and wool -- when rubbed against each other -- produced a physical attraction. Again, physicists would describe this interaction in terms of *electric fields* generated by the two objects as a result of their electron imbalances. Suffice it to say that whenever a voltage exists between two points, there will be an electric field manifested in the space between those points.

Fields have two measures: a field *force* and a field *flux*. The field *force* is the amount of "push" that a field exerts over a certain distance. The field *flux* is the total quantity, or effect, of the field through space. Field force and flux are roughly analogous to voltage ("push") and current (flow) through a conductor, respectively, although field flux can exist in totally empty space (without the motion of particles such as electrons) whereas current can only take place where there are free electrons to move. Field flux can be opposed in space, just as the flow of electrons can be opposed by resistance. The amount of field flux that will develop in space is proportional to the amount of field force applied, divided by the amount of opposition to flux. Just as the type of conducting material dictates that conductor's specific resistance to electric current, the type of insulating material separating two conductors dictates the specific opposition to field flux.

Normally, electrons cannot enter a conductor unless there is a path for an equal amount of electrons to exit (remember the marble-in-tube analogy?). This is why conductors must be connected together in a circular path (a circuit) for continuous current to occur. Oddly enough, however, extra electrons can be "squeezed" into a conductor without a path to exit if an electric field is allowed to develop in space relative to another conductor. The number of extra free electrons added to the conductor (or free electrons taken away) is directly proportional to the amount of field flux between the two conductors.

http://www.allaboutcircuits.com/vol_1/chpt_13/1.html

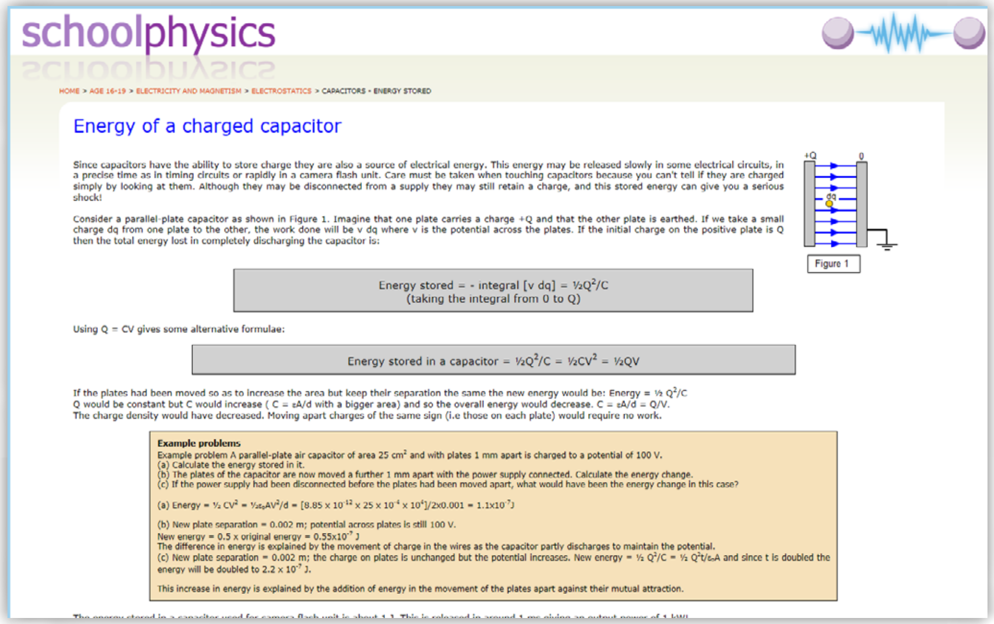
Description:
Series of web pages explaining electric field strength and capacitance.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Web page

Energy of a charged capacitor



schoolphysics

HOME > AGE 16-19 > ELECTRICITY AND MAGNETISM > ELECTROSTATICS > CAPACITORS - ENERGY STORED

Energy of a charged capacitor

Since capacitors have the ability to store charge they are also a source of electrical energy. This energy may be released slowly in some electrical circuits, in a precise time as in timing circuits or rapidly in a camera flash unit. Care must be taken when touching capacitors because you can't tell if they are charged simply by looking at them. Although they may be disconnected from a supply they may still retain a charge, and this stored energy can give you a serious shock!

Consider a parallel-plate capacitor as shown in Figure 1. Imagine that one plate carries a charge +Q and that the other plate is earthed. If we take a small charge dq from one plate to the other, the work done will be v dq where v is the potential across the plates. If the initial charge on the positive plate is Q then the total energy lost in completely discharging the capacitor is:

Figure 1

Energy stored = - integral [v dq] = ½Q^2/C
(taking the integral from 0 to Q)

Using Q = CV gives some alternative formulae:

Energy stored in a capacitor = ½Q^2/C = ½CV^2 = ½QV

If the plates had been moved so as to increase the area but keep their separation the same the new energy would be: Energy = ½ Q^2/C
Q would be constant but C would increase (C = εA/d with a bigger area) and so the overall energy would decrease. C = εA/d = Q/V.
The charge density would have decreased. Moving apart charges of the same sign (i.e those on each plate) would require no work.

Example problems
Example problem A parallel-plate air capacitor of area 25 cm^2 and with plates 1 mm apart is charged to a potential of 100 V.
(a) Calculate the energy stored in it.
(b) The plates of the capacitor are now moved a further 1 mm apart with the power supply connected. Calculate the energy change.
(c) If the power supply had been disconnected before the plates had been moved apart, what would have been the energy change in this case?

(a) Energy = ½ CV^2 = ½$\varepsilon_0 AV^2/d$ = [8.85 x 10^{-12} x 25 x 10^{-4} x 10^4]/2x0.001 = 1.1x10^{-7}J

(b) New plate separation = 0.002 m; potential across plates is still 100 V.
New energy = 0.5 x original energy = 0.55x10^{-7} J
The difference in energy is explained by the movement of charge in the wires as the capacitor partly discharges to maintain the potential.
(c) New plate separation = 0.002 m; the charge on plates is unchanged but the potential increases. New energy = ½ Q^2/C = ½ $Q^2t/\varepsilon_0 A$ and since t is doubled the energy will be doubled to 2.2 x 10^{-7} J.

This increase in energy is explained by the addition of energy in the movement of the plates apart against their mutual attraction.

http://www.schoolphysics.co.uk/age16-19/Electricity%20and%20magnetism/Electrostatics/text/Capacitor_energy_stored/index.html

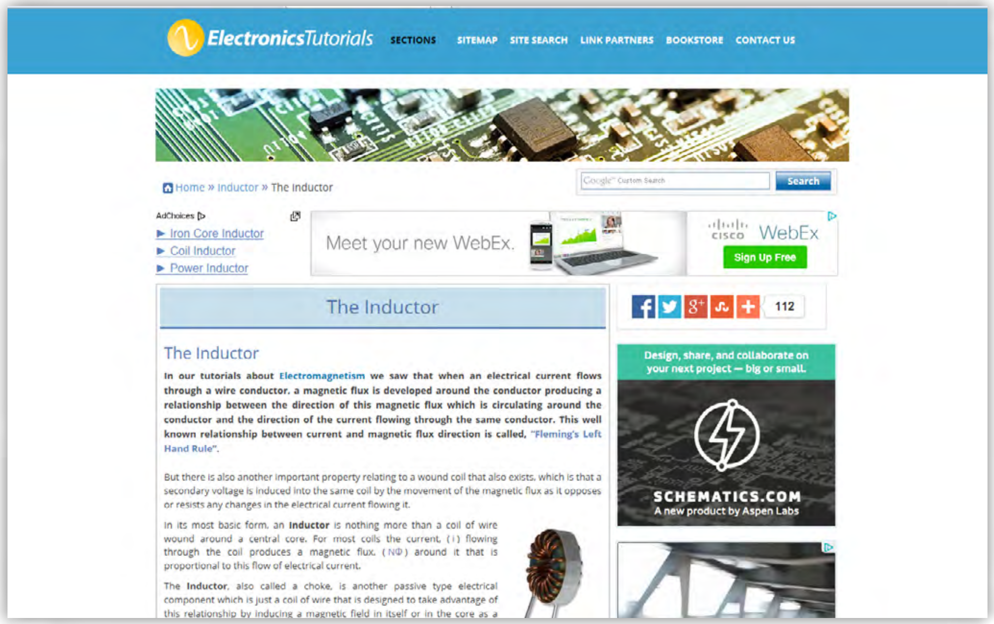
Description:
Description with equations of energy stored in a capacitor.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Web page

Inductors and inductance – energy in an inductor



http://www.electronics-tutorials.ws/inductor/inductor.html

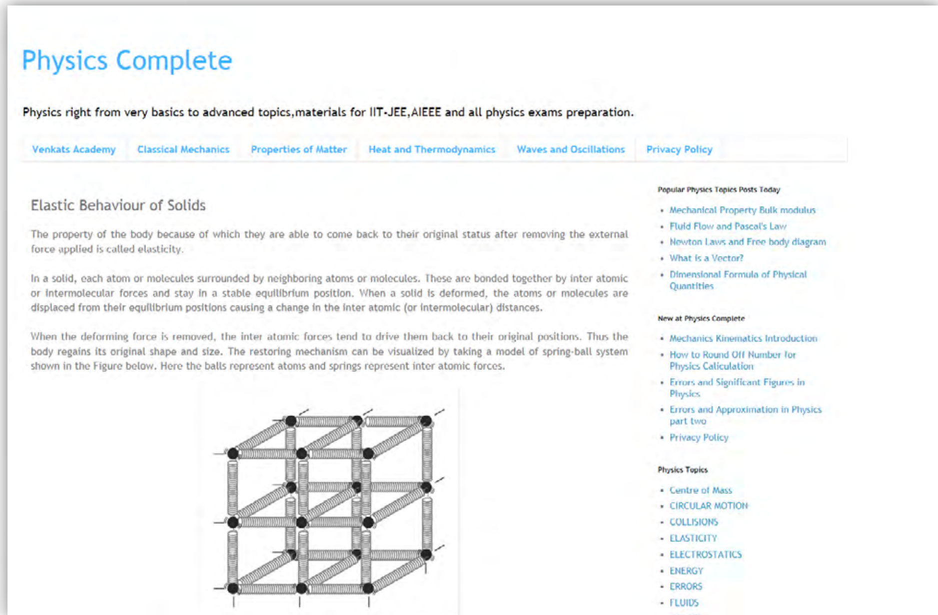
Description:
Complete explanation about inductance and inductors, including energy stored in an inductor.

Supports:
OCR Cambridge Technicals in Engineering Level 3
Unit 2

Cost:
Free

Format:
Web page

Elastic behaviour of solids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Elastic Behaviour of Solids

The property of the body because of which they are able to come back to their original status after removing the external force applied is called elasticity.

In a solid, each atom or molecules surrounded by neighboring atoms or molecules. These are bonded together by inter atomic or intermolecular forces and stay in a stable equilibrium position. When a solid is deformed, the atoms or molecules are displaced from their equilibrium positions causing a change in the inter atomic (or intermolecular) distances.

When the deforming force is removed, the inter atomic forces tend to drive them back to their original positions. Thus the body regains its original shape and size. The restoring mechanism can be visualized by taking a model of spring-ball system shown in the Figure below. Here the balls represent atoms and springs represent inter atomic forces.

Popular Physics Topics Posts Today

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Physics Topics

- Centre of Mass
- CIRCULAR MOTION
- COLLISIONS
- ELASTICITY
- ELECTROSTATICS
- ENERGY
- ERRORS
- FLUIDS

http://physicspractice.blogspot.co.uk/2009/02/elastic-behaviour-of-solids.html

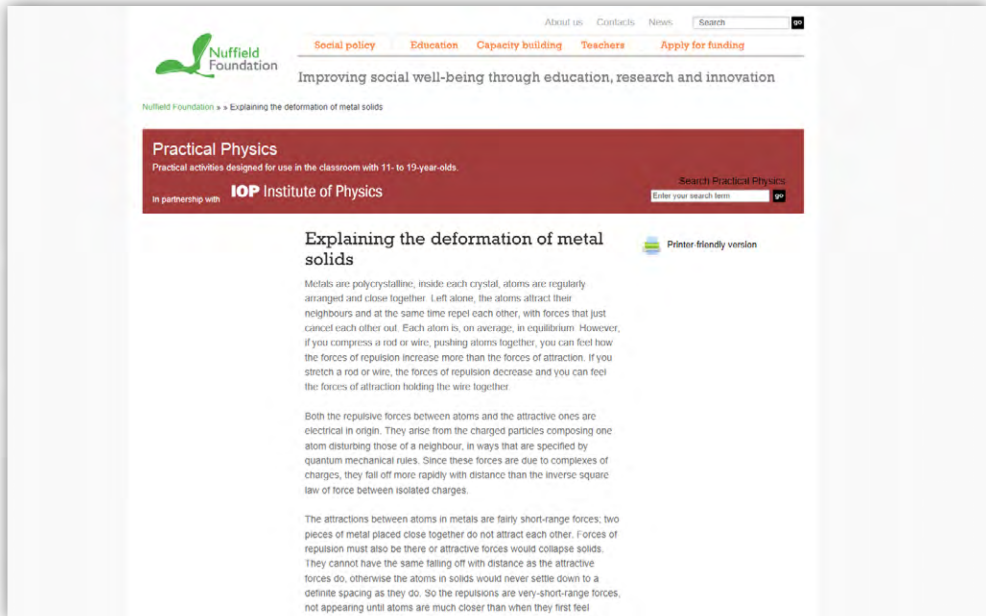
Description:
A basic introduction to the elastic behaviour of solids at the atomic level.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Web page

Deformation of metal solids – atomic attraction and repulsion



http://www.nuffieldfoundation.org/practical-physics/explaining-deformation-metal-solids

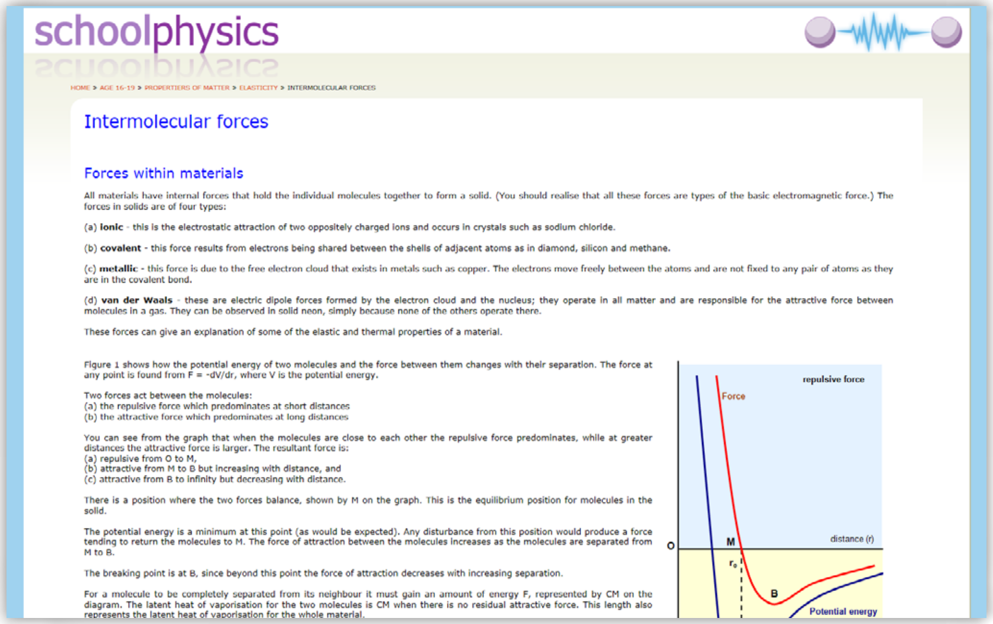
Description:
A good description of how atoms are attracted and repelled in metal solids. Includes sketch illustrating intermolecular forces.

Supports:
OCR Cambridge Technicals in Engineering Level 3
Unit 2

Cost:
Free

Format:
Web page

Molecular separation (equilibrium)



http://www.schoolphysics.co.uk/age16-19/Properties%20of%20matter/Elasticity/text/Intermolecular_forces/index.html

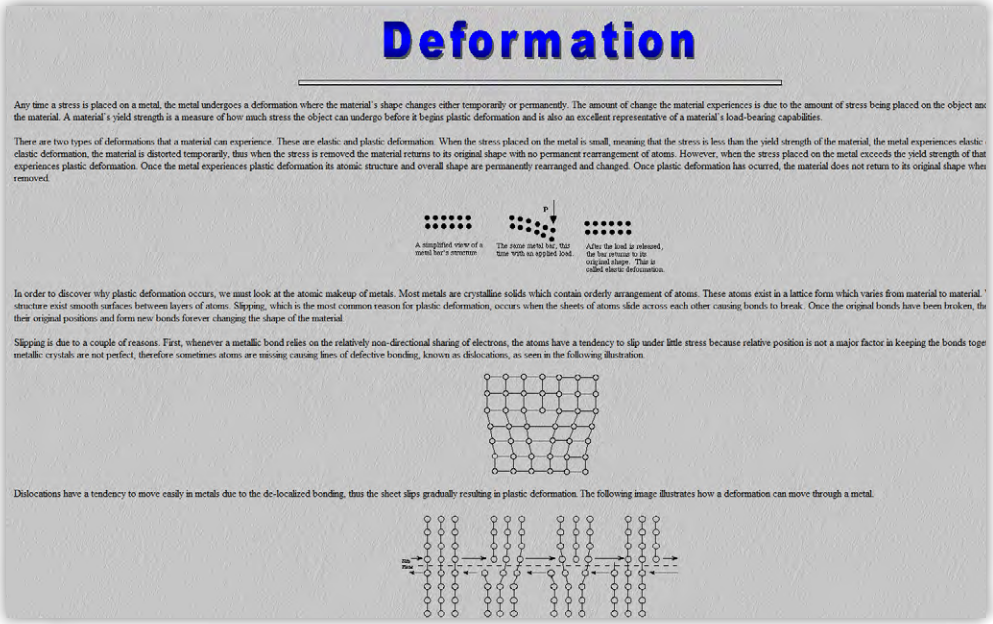
Description:
Further explanation of the forces of attraction and repulsion between atoms – including equilibrium and separation.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Web page

Elastic and plastic deformation



http://www.phy.davidson.edu/StuHome/BeKinneman/metal/deformation.htm

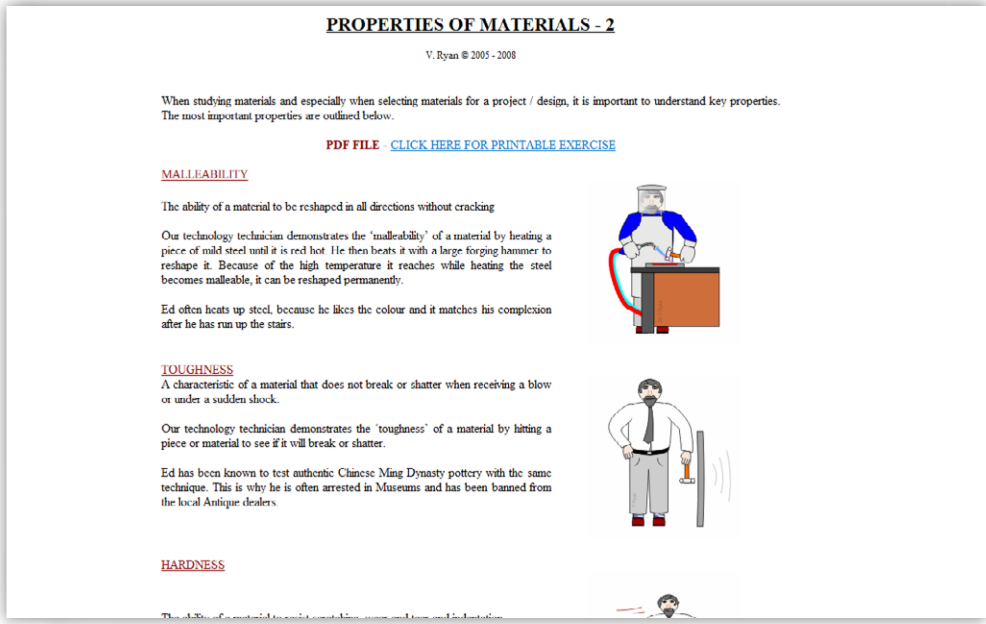
Description:
An explanation of elastic and plastic deformation at the molecular level. Includes the term 'slip'.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Web page

Properties of materials



PROPERTIES OF MATERIALS - 2

V. Ryan © 2005 - 2008

When studying materials and especially when selecting materials for a project / design, it is important to understand key properties. The most important properties are outlined below.

PDF FILE - CLICK HERE FOR PRINTABLE EXERCISE

MALLEABILITY

The ability of a material to be reshaped in all directions without cracking

Our technology technician demonstrates the 'malleability' of a material by heating a piece of mild steel until it is red hot. He then beats it with a large forging hammer to reshape it. Because of the high temperature it reaches while heating the steel becomes malleable, it can be reshaped permanently.

Ed often heats up steel, because he likes the colour and it matches his complexion after he has run up the stairs.

TOUGHNESS

A characteristic of a material that does not break or shatter when receiving a blow or under a sudden shock.

Our technology technician demonstrates the 'toughness' of a material by hitting a piece or material to see if it will break or shatter.

Ed has been known to test authentic Chinese Ming Dynasty pottery with the same technique. This is why he is often arrested in Museums and has been banned from the local Antique dealers.

HARDNESS

http://www.technologystudent.com/joints/matprop2.htm

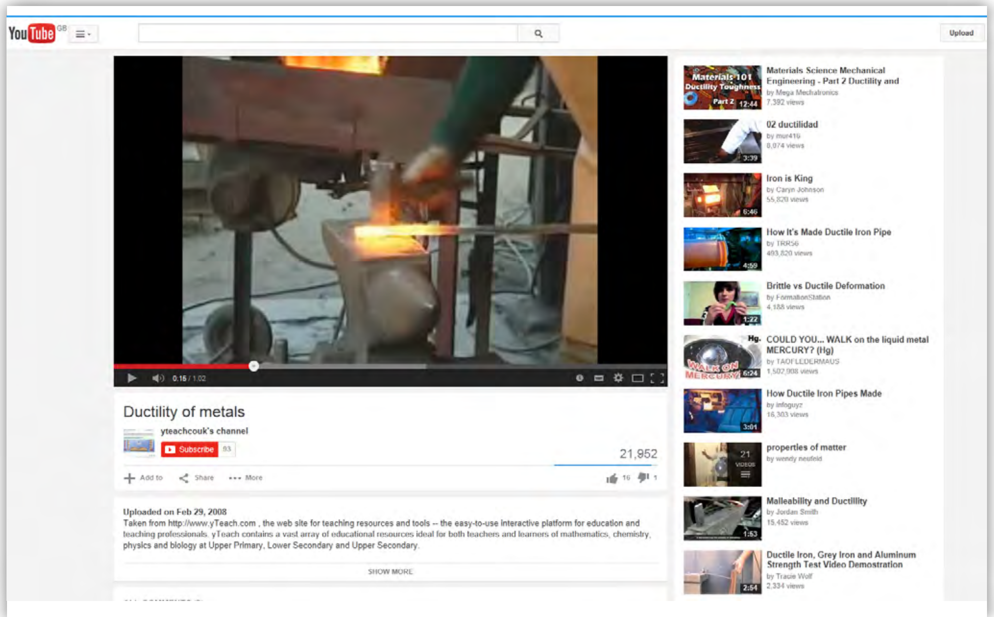
Description:
A basic introduction to some of the mechanical properties of materials.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Web page

Malleability



https://www.youtube.com/watch?v=OkuDM3hYutI

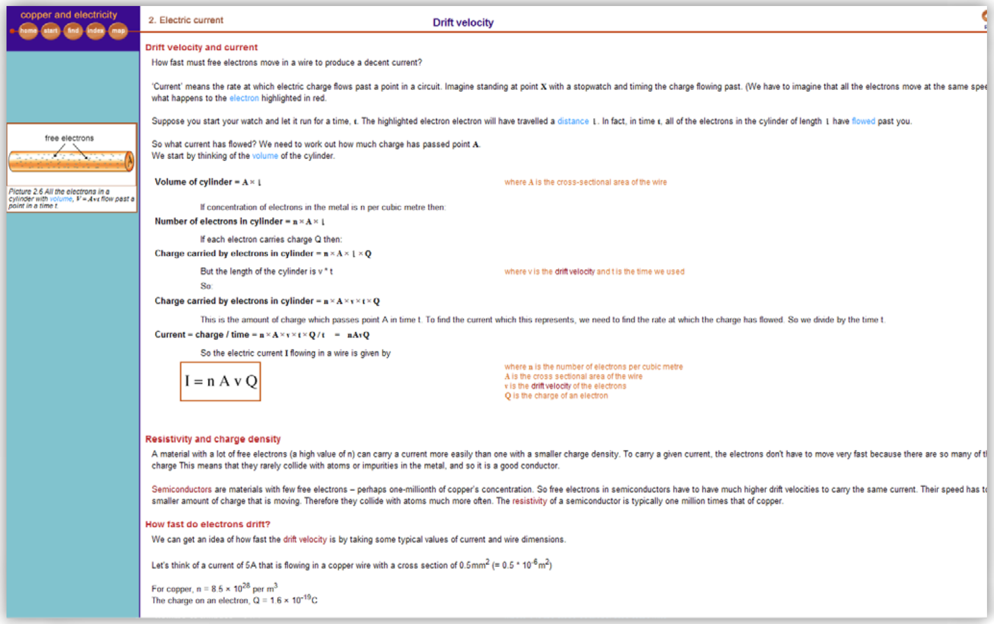
Description:
YouTube video showing malleability of hot metals. YouTube contains further videos illustrating material properties such as ductility, brittleness, endurance and hardness.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
YouTube video

Drift velocity and current



http://resources.schoolscience.co.uk/CDA/16plus/copelech2pg3.html

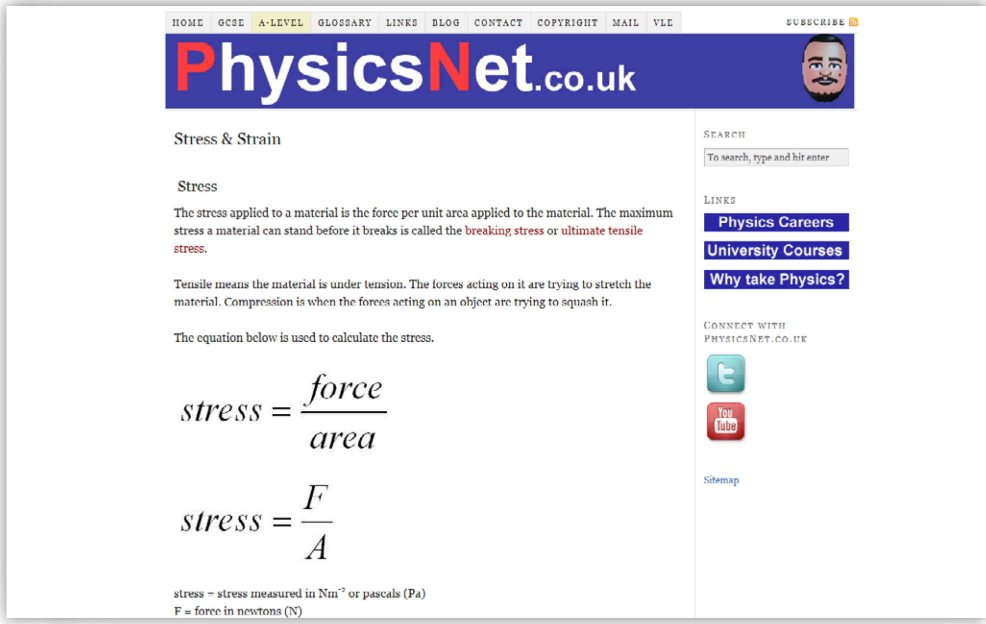
Description:
Explanation of drift velocity and current flow – including formulae.

Supports:
OCR Cambridge Technicals in Engineering Level 3
Unit 2

Cost:
Free

Format:
Web page

Stress and Strain



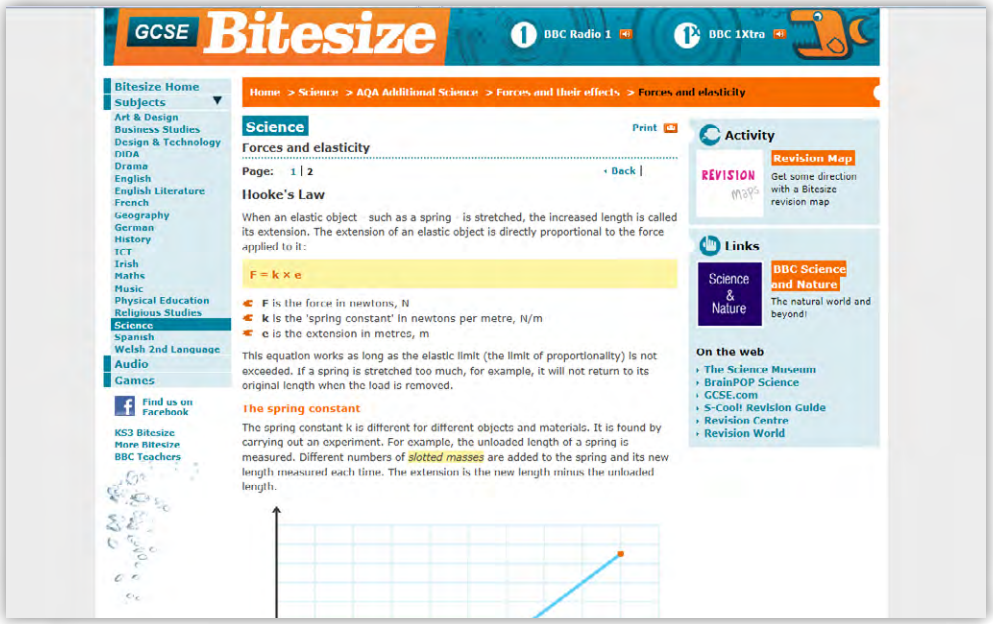
http://physicsnet.co.uk/a-level-physics-as-a2/materials/stress-strain/

Description:
A basic introduction to stress and strain – including stress/strain graphs and formulae.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Web page



http://www.bbc.co.uk/schools/gcsebitesize/science/add_aqa/forces/forceselasticityrev2.shtml

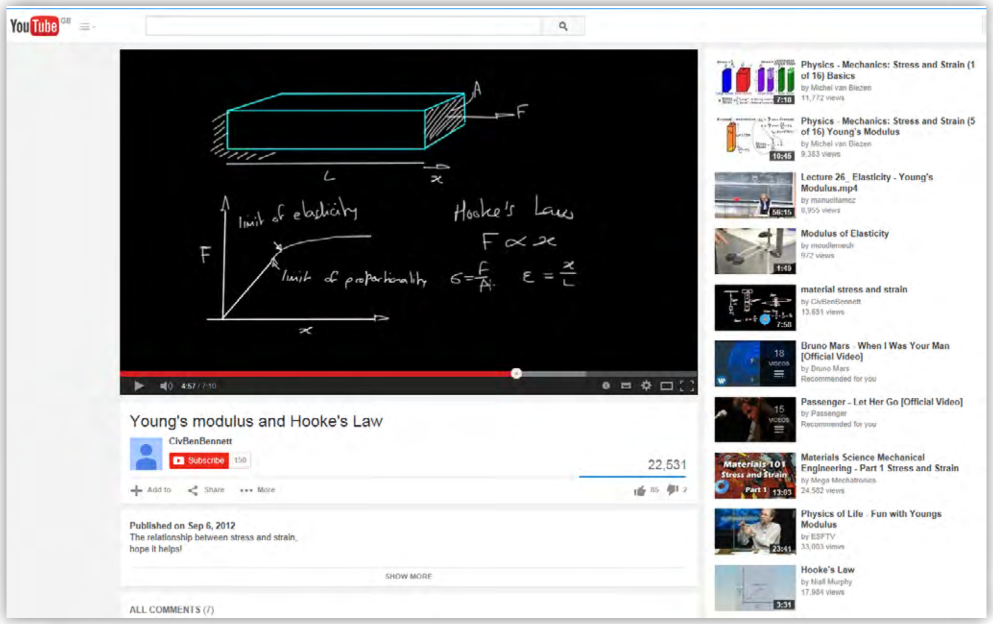
Description:
Basic introduction to Hooke's Law.

Supports:
OCR Cambridge Technicals in Engineering Level 3
Unit 2

Cost:
Free

Format:
Web page

Stress strain, Young's Modulus and Hooke's Law



https://www.youtube.com/watch?v=KxxTTf7kUTM

Description:
A video explaining the relationship between stress and strain, and also Young's Modulus and Hooke's Law.

Supports:
OCR Cambridge Technicals in Engineering Level 3
Unit 2

Cost:
Free

Format:
YouTube Video

British Institute of Non-destructive Testing (BINDT)

http://www.bindt.org/videos/

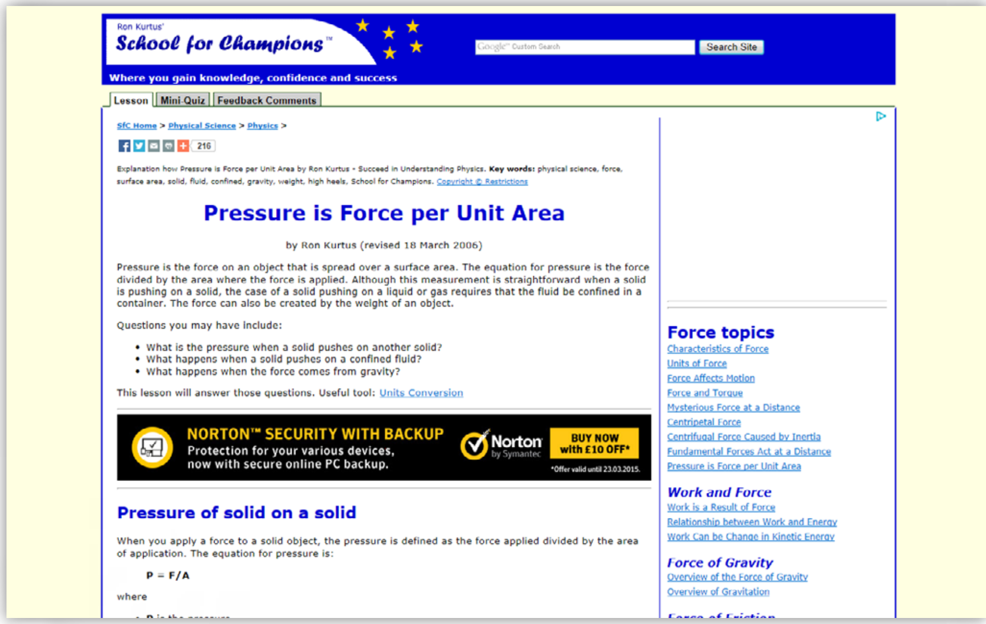
Description:
Website of the British Institute of Non-destructive Testing (BINDT). Includes many useful resources including videos explaining NDT and NDT techniques.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Web page with video resources

Pressure is Force per unit Area



http://www.school-for-champions.com/science/pressure.htm

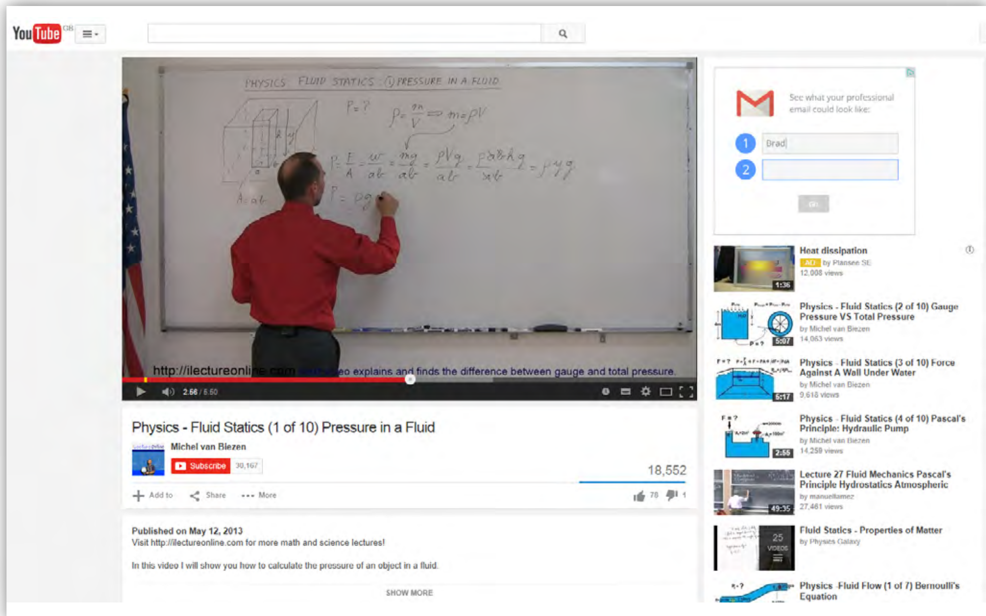
Description:
Explanation of the relationship between pressure, force and area. Discusses liquids and gases (hydrostatic pressure).

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Web page

Fluid Statics – pressure in fluids



https://www.youtube.com/watch?v=mzjlAla3H1Q

Description:
Introductory video to pressure in fluids. Includes derivation of pressure equation, and pressure due to a height of a column of liquid. Includes links to a further series of videos. Note: height is termed y and not h in the video.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Youtube video

Gauge Pressure and Absolute Pressure


NPL

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Home > Reference > FAQs

What are absolute, gauge and differential pressures 'modes'? (FAQ - Pressure)

Home

Reference

- FAQs

To avoid ambiguity, when referring to a pressure value it is important to specify its *mode*. What are pressure modes?

If a vessel were to contain no molecules whatsoever, the pressure would be zero. Pressures measured on a scale which uses this zero value as their reference point are said to be *absolute* pressures. Atmospheric pressure at the surface of the earth varies but is approximately 10^5 Pa (1 000 mbar, 1 000 hPa); this is 10^5 Pa *absolute* pressure because it is expressed with respect to zero pressure - that is no molecules at all.

In everyday life, however, many applications of pressure are not so much dependent on the absolute value of a pressure as the difference between it and the pressure of the atmosphere. A punctured car tyre is said to have 'no air in it' and a connected tyre pressure gauge would read 'zero' whilst obviously still containing atmospheric air. Such gauges are designed to measure pressure values that are expressed with respect to atmospheric pressure and thus indicate zero when the measurement port 'merely' contains molecules at atmospheric pressure. These measurements are known as *gauge* pressure measurements. Thus the difference between an absolute pressure value and a gauge pressure value is the variable value of atmospheric pressure:

Absolute pressure = gauge pressure + atmospheric pressure

In some cases - for example when measuring the pressure reduction in an engine manifold - it is the value of the pressure reduction *below* the external 'reference' atmospheric pressure which is required, rather than the absolute value of the pressure. This is sometimes known as a *negative gauge pressure* measurement but it should be appreciated that the concept of a negative absolute pressure is meaningless.

In other applications, where knowledge of the pressure difference between two places or systems is needed, the reference pressure may not necessarily be either zero or atmospheric pressure but some other value.

http://www.npl.co.uk/reference/faqs/what-are-absolute,-gauge-and-differential-pressures-'modes'-(faq-pressure)

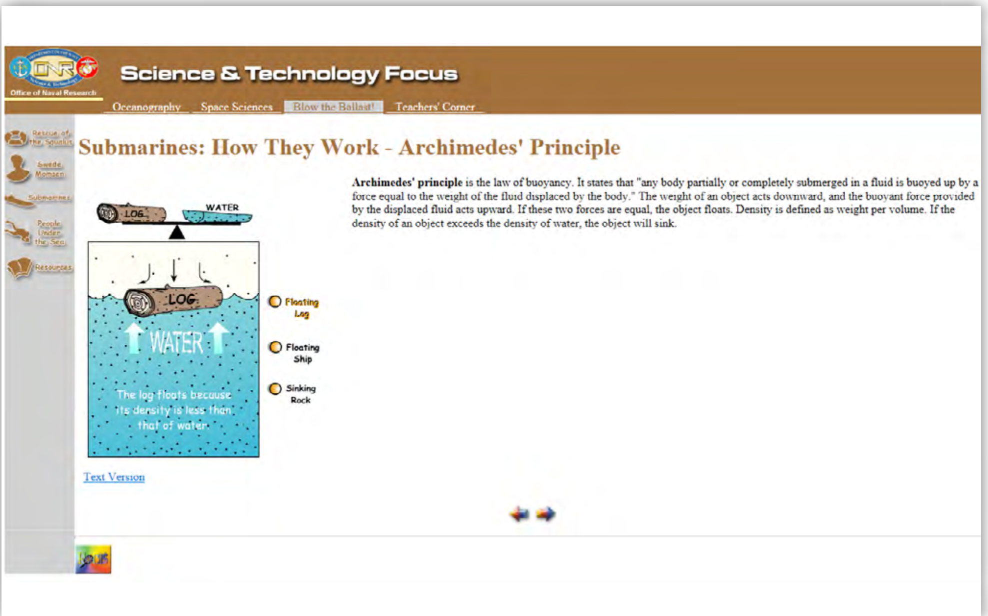
Description:
An explanation of the difference between absolute and gauge pressure.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Webpage

Archimedes' Principle



http://www.onr.navy.mil/focus/blowballast/sub/work2.htm

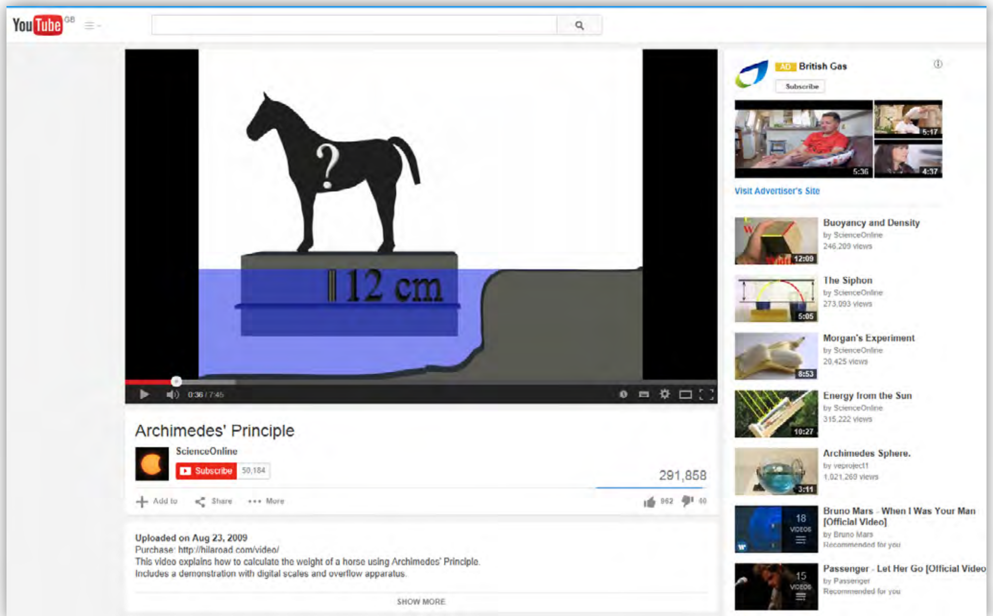
Description:
An interactive explanation of Archimedes' Principle.

Supports:
OCR Cambridge Technicals in Engineering Level 3
Unit 2

Cost:
Free

Format:
Webpage

Archimedes' Principle



https://www.youtube.com/watch?v=eQsmq3Hu9HA

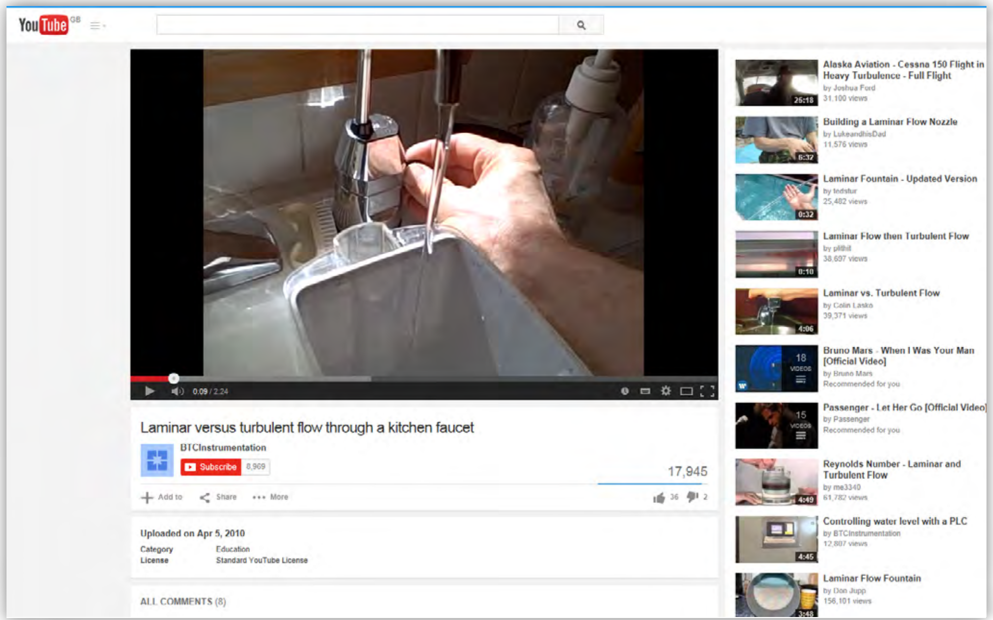
Description:
Video showing experiments that demonstrate Archimedes' Principle. Includes calculations showing that the up-thrust force is equal to the weight of displaced fluid.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
YouTube video

Laminar and Turbulent Flow



https://www.youtube.com/watch?v=VoBc60iUq2I

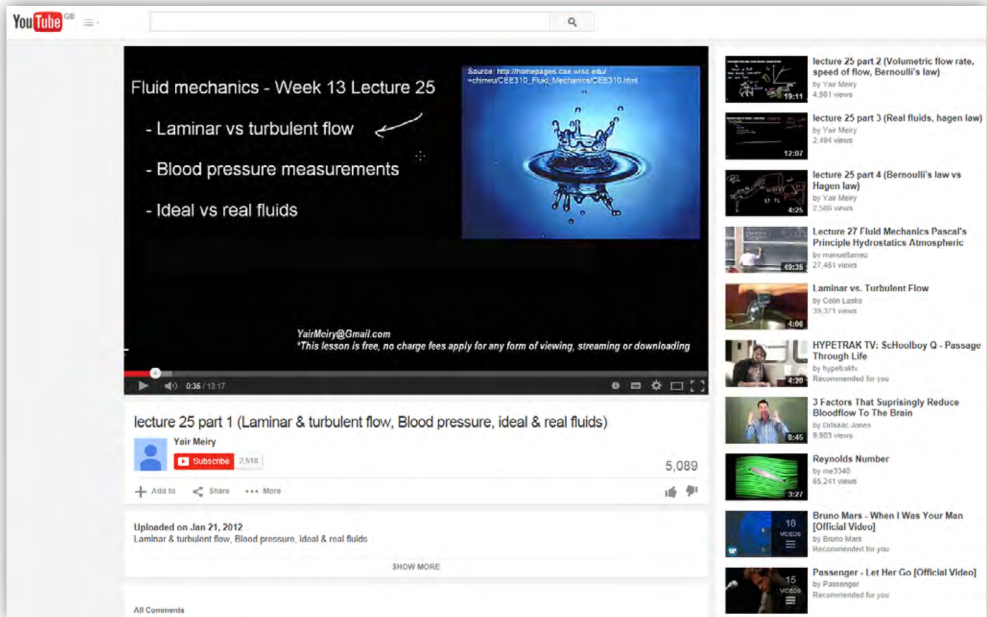
Description:
A simple demonstration using water from a tap of laminar and turbulent fluid flow.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
YouTube video

Laminar and Turbulent Flow – Ideal and Real Fluids



https://www.youtube.com/watch?v=Q2cpuJIWW-o

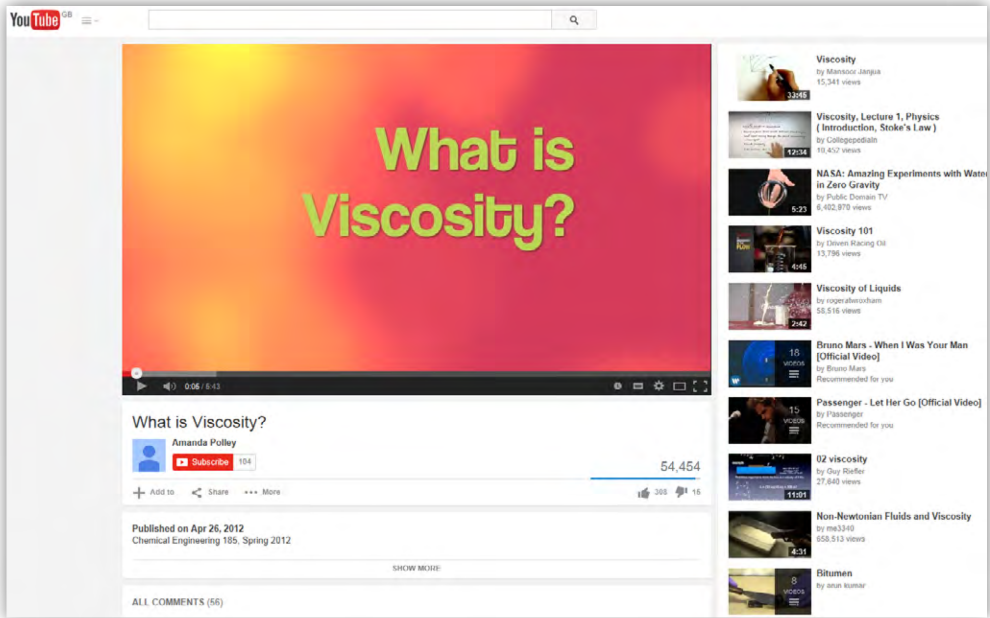
Description:
A video explaining laminar and turbulent flow. Also explains the differences between ideal and real fluids.

Supports:
OCR Cambridge Technicals in Engineering Level 3
Unit 2

Cost:
Free

Format:
YouTube video

What is viscosity?



http://www.youtube.com/watch?v=1AESWxko4nI

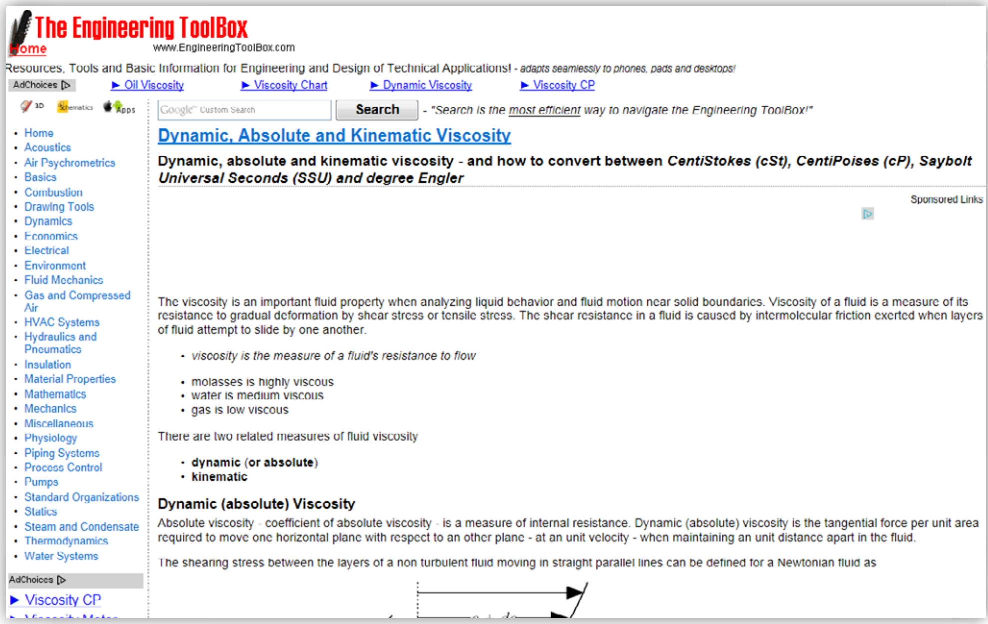
Description:
Explanation of viscosity with demonstration using milk and honey. Includes reference to Kinematic velocity and temperature.

Supports:
OCR Cambridge Technicals in Engineering Level 3
Unit 2

Cost:
Free

Format:
YouTube video

Dynamic (absolute) and Kinematic Viscosity



http://www.engineeringtoolbox.com/dynamic-absolute-kinematic-viscosity-d_412.html

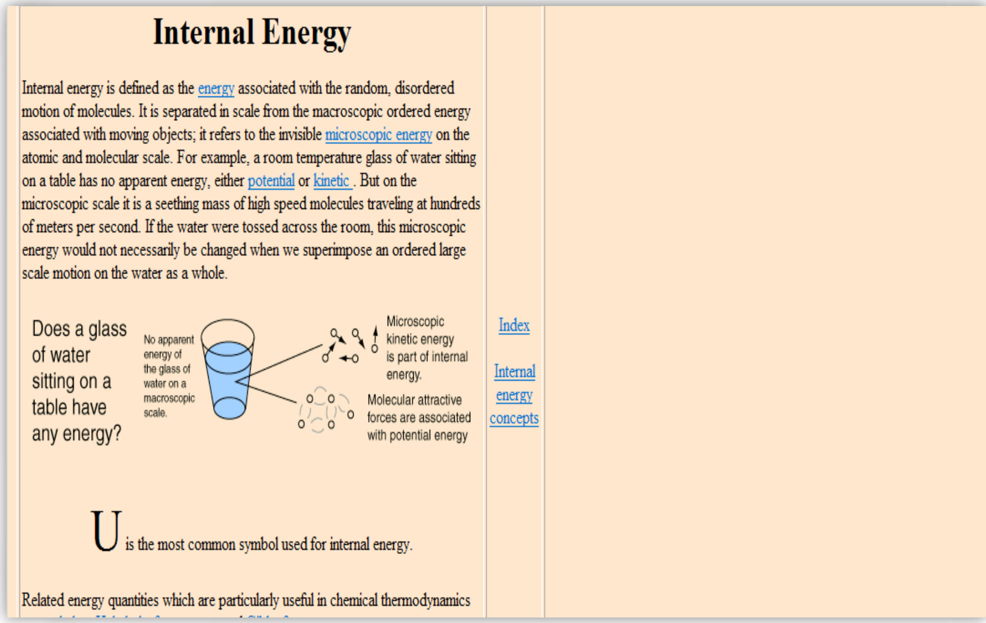
Description:
Explanation of the differences between dynamic and Kinematic viscosity – including defining equations and examples. Has a typical value for different liquids.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Webpage

Internal energy



Internal Energy

Internal energy is defined as the energy associated with the random, disordered motion of molecules. It is separated in scale from the macroscopic ordered energy associated with moving objects; it refers to the invisible microscopic energy on the atomic and molecular scale. For example, a room temperature glass of water sitting on a table has no apparent energy, either potential or kinetic . But on the microscopic scale it is a seething mass of high speed molecules traveling at hundreds of meters per second. If the water were tossed across the room, this microscopic energy would not necessarily be changed when we superimpose an ordered large scale motion on the water as a whole.

Index

Internal energy concepts

U is the most common symbol used for internal energy.

Related energy quantities which are particularly useful in chemical thermodynamics

http://hyperphysics.phy-astr.gsu.edu/hbase/thermo/inteng.html

Description:
A simple description of internal energy consisting of both kinetic and potential energy.

Supports:
OCR Cambridge Technicals in Engineering Level 3
Unit 2

Cost:
Free

Format:
Webpage

Absolute temperature and the Kelvin scale

https://www.khanacademy.org/test-prep/mcat/physical-processes/gas-phase/v/absolute-temperature-and-the-kelvin-scale

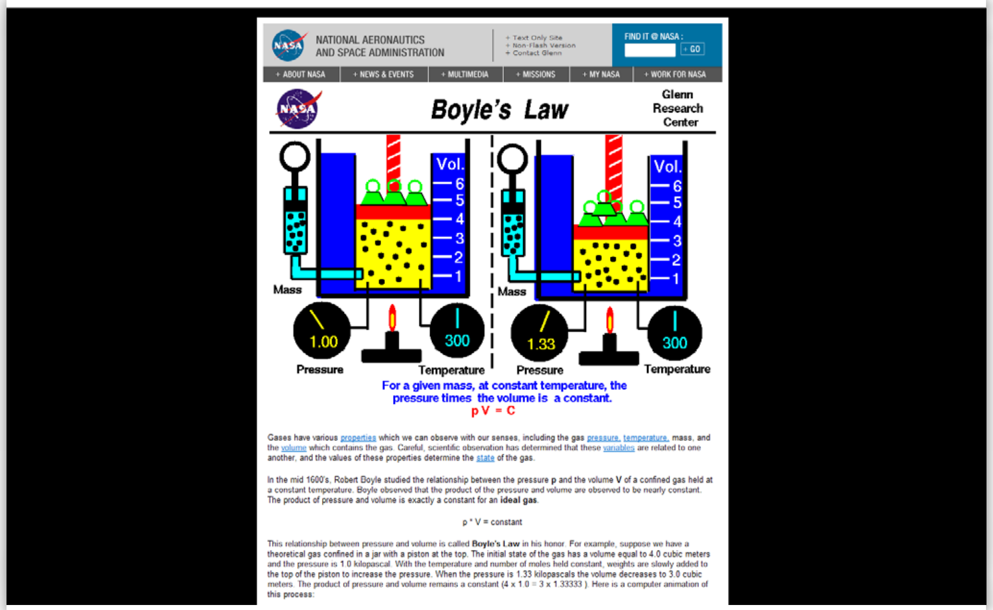
Description:
A video tutorial explaining the relationship between the Kelvin scale with Celsius and Fahrenheit scales. Relates temperature to internal energy.

Supports:
OCR Cambridge Technicals in Engineering Level 3
Unit 2

Cost:
Free

Format:
Webpage

Boyle's Law



http://www.grc.nasa.gov/WWW/k-12/airplane/boyle.html

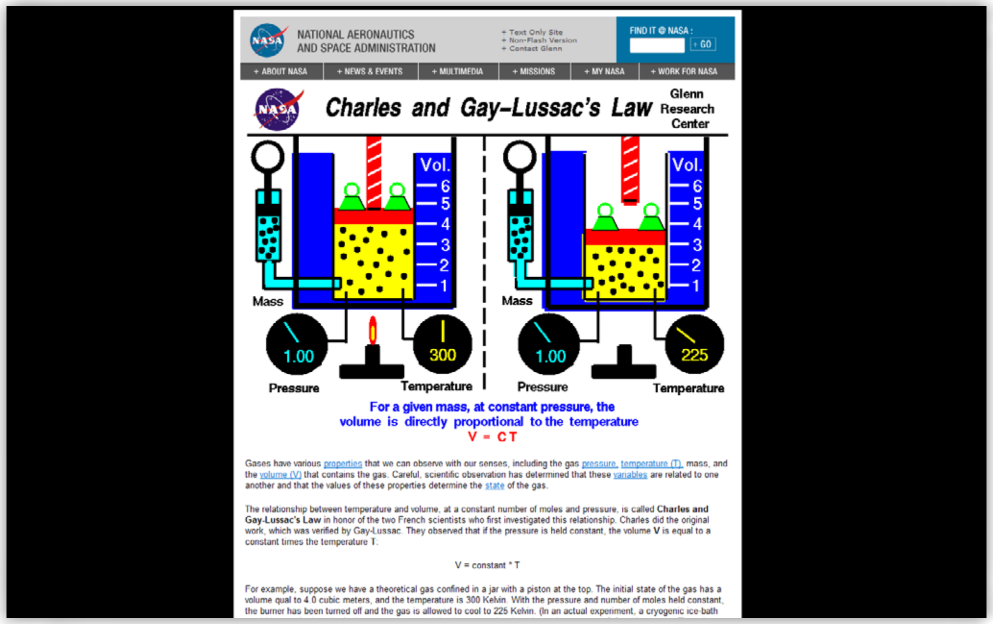
Description:
An interactive explanation (with characteristic equation) of Boyles Law.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Webpage

Charles' Law



http://www.grc.nasa.gov/WWW/k-12/airplane/glussac.html

Description:
An interactive explanation of Charles' Law (also makes the associated Gay-Lussac's Law).

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Webpage

Pressure Law

http://www.passmyexams.co.uk/GCSE/physics/pressure-temperature-relationship-of-gas-pressure-law.html

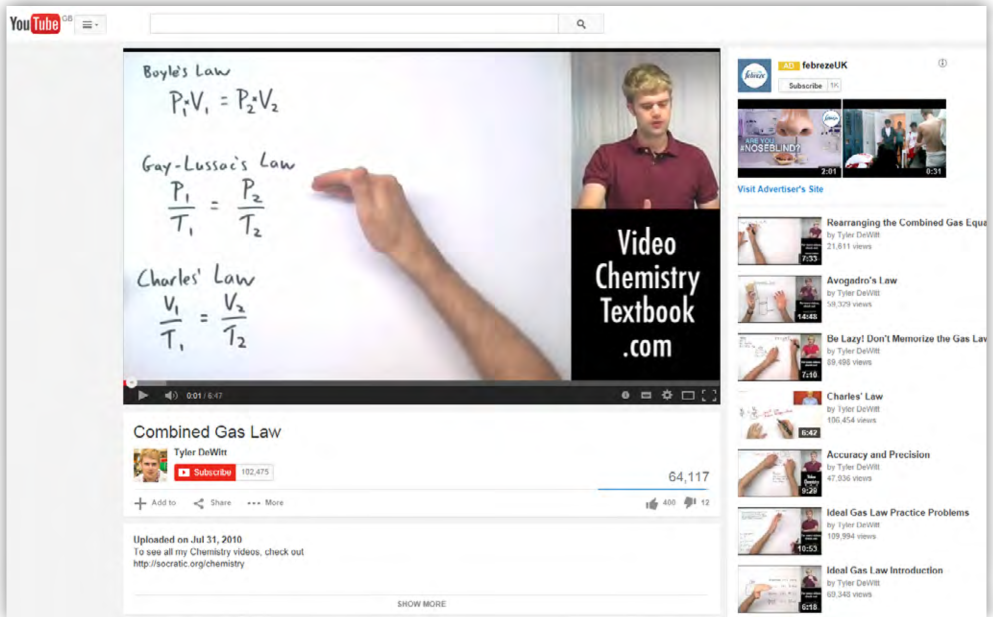
Description:
An interactive explanation of the Pressure Law. Includes calculations and worked examples of using the characteristic formula.

Supports:
OCR Cambridge Technicals in Engineering Level 3
Unit 2

Cost:
Free

Format:
Webpage

Combined Gas Law



https://www.youtube.com/watch?v=bftkRnTcFj8

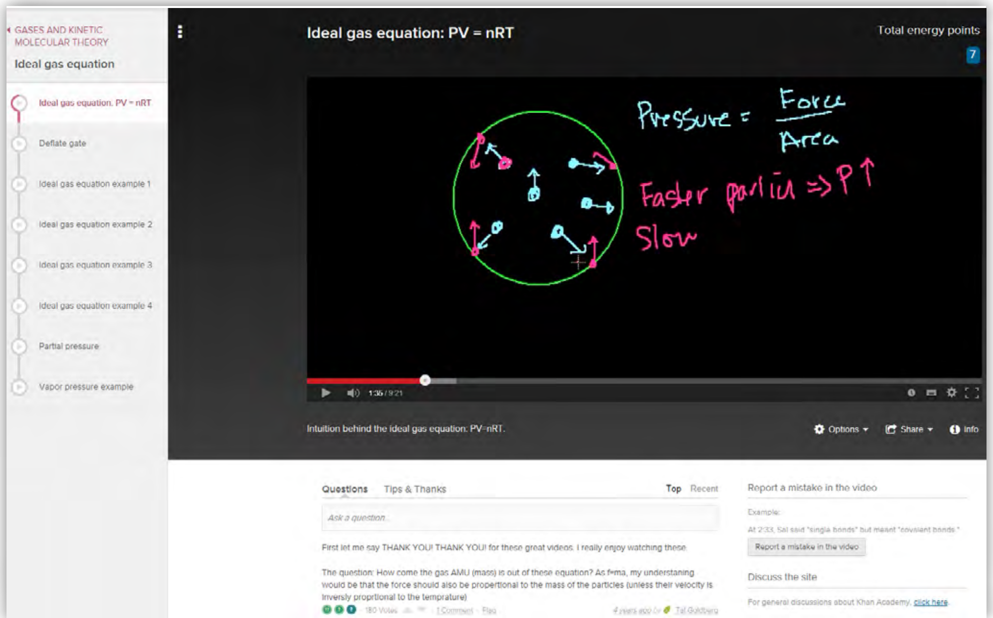
Description:
A YouTube video tutorial relating Boyles, Charles and Gay-Lussac's Laws to the Combined Pressure Law. Includes a worked example.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Youtube video

Characteristic (Ideal) Gas Equation



http://www.khanacademy.org/science/chemistry/ideal-gas-laws/v/ideal-gas-equation-pv-nrt

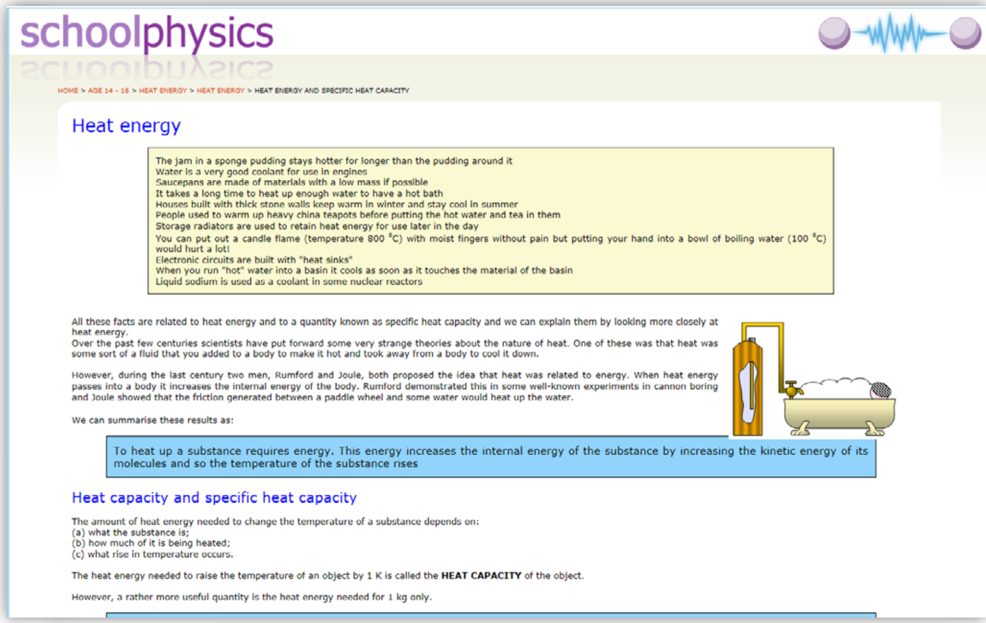
Description:
A video tutorial covering the characteristic (ideal) gas equation. Includes further video worked examples.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Web page with video resources

Heat energy (including heat capacity and specific heat capacity)


schoolphysics

HOME > AGE 14 - 16 > HEAT ENERGY > HEAT ENERGY > HEAT ENERGY AND SPECIFIC HEAT CAPACITY

Heat energy

The jam in a sponge pudding stays hotter for longer than the pudding around it
Water is a very good coolant for use in engines
Saucepans are made of materials with a low mass if possible
It takes a long time to heat up enough water to have a hot bath
Houses built with thick stone walls keep warm in winter and stay cool in summer
People used to warm up heavy china teapots before putting the hot water and tea in them
Storage radiators are used to retain heat energy for use later in the day
You can put out a candle flame (temperature 800 °C) with moist fingers without pain but putting your hand into a bowl of boiling water (100 °C) would hurt a lot!
Electronic circuits are built with "heat sinks"
When you run "hot" water into a basin it cools as soon as it touches the material of the basin
Liquid sodium is used as a coolant in some nuclear reactors

All these facts are related to heat energy and to a quantity known as specific heat capacity and we can explain them by looking more closely at heat energy.
Over the past few centuries scientists have put forward some very strange theories about the nature of heat. One of these was that heat was some sort of a fluid that you added to a body to make it hot and took away from a body to cool it down.

However, during the last century two men, Rumford and Joule, both proposed the idea that heat was related to energy. When heat energy passes into a body it increases the internal energy of the body. Rumford demonstrated this in some well-known experiments in cannon boring and Joule showed that the friction generated between a paddle wheel and some water would heat up the water.

We can summarise these results as:

To heat up a substance requires energy. This energy increases the internal energy of the substance by increasing the kinetic energy of its molecules and so the temperature of the substance rises

Heat capacity and specific heat capacity

The amount of heat energy needed to change the temperature of a substance depends on:
(a) what the substance is;
(b) how much of it is being heated;
(c) what rise in temperature occurs.

The heat energy needed to raise the temperature of an object by 1 K is called the **HEAT CAPACITY** of the object.

However, a rather more useful quantity is the heat energy needed for 1 kg only.

http://www.schoolphysics.co.uk/age14-16/Heat%20energy/Heat%20energy/text/Specific_heat_capacity_and_heat_energy/index.html?PHPSESSID=b2810791ba27022d9331843c394d05c5

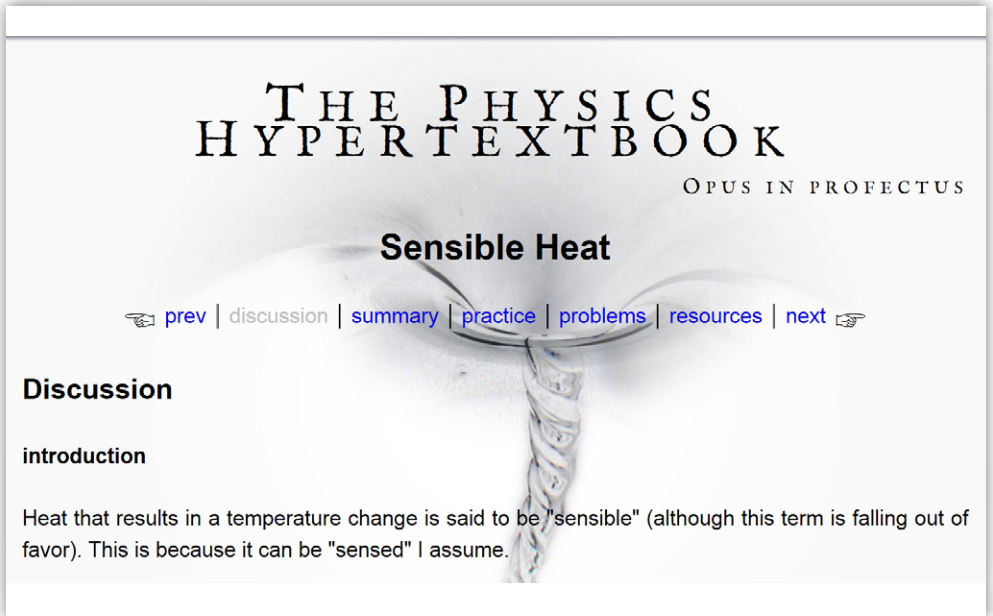
Description:
An introduction to heat energy, including a definition for specific heat capacity.

Supports:
OCR Cambridge Technicals in Engineering Level 3
Unit 2

Cost:
Free

Format:
Web page

Sensible Heatcapacity)



http://physics.info/heat-sensible/

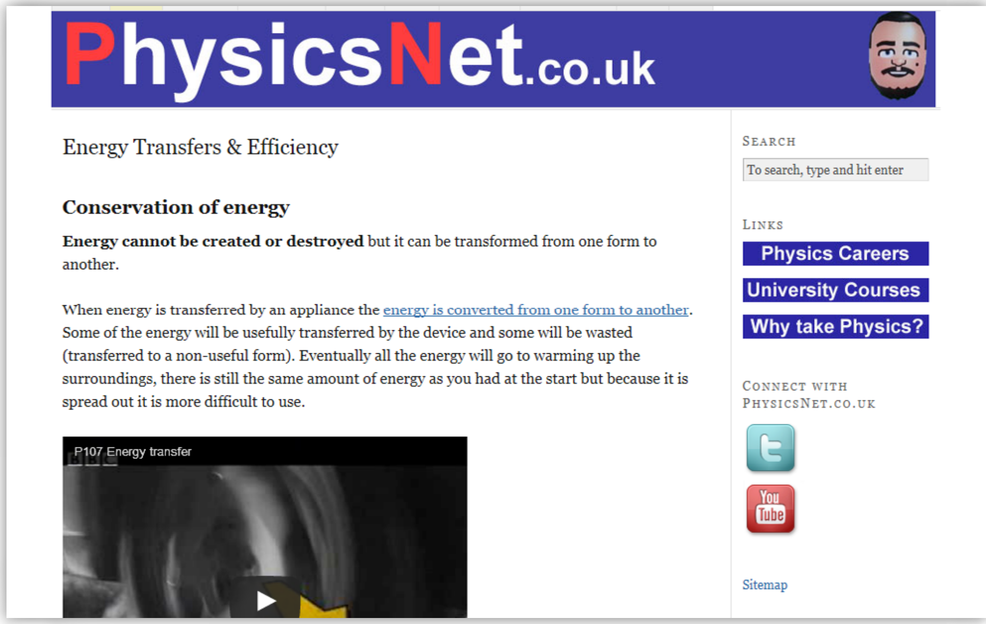
Description:
A further explanation of specific (or sensible) heat. Includes a historic timeline, and specific heat for different materials. Also has practice problems and further examples.

Supports:
OCR Cambridge Technicals in Engineering Level 3
Unit 2

Cost:
Free

Format:
Web page

Efficiency



http://physicsnet.co.uk/gcse-physics/energy-transfers-efficiency/

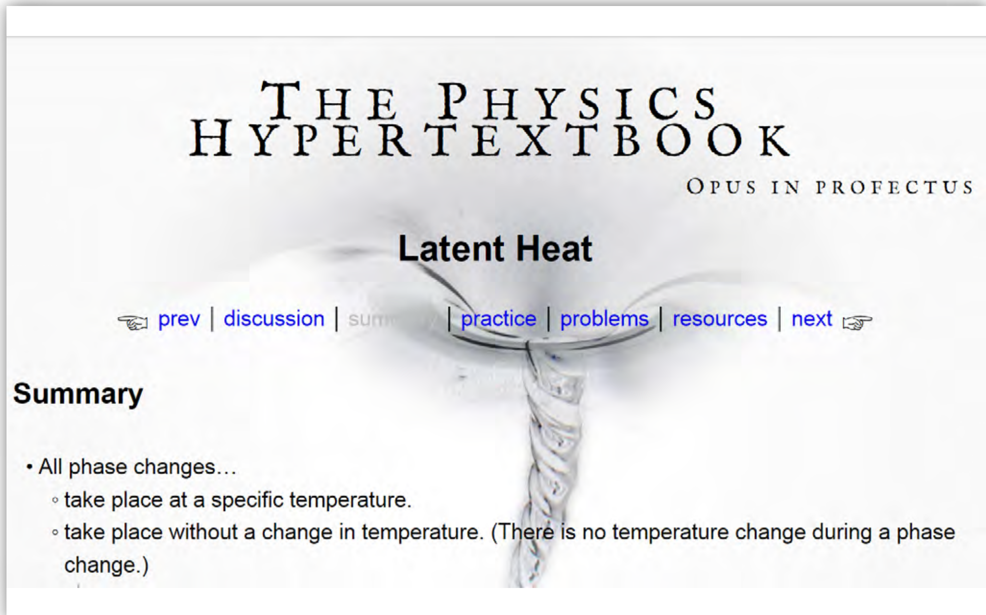
Description:
A recap on the term efficiency. Includes worked examples.

Supports:
OCR Cambridge Technicals in Engineering Level 3
Unit 2

Cost:
Free

Format:
Web page

Latent Heat



http://physics.info/heat-latent/summary.shtml

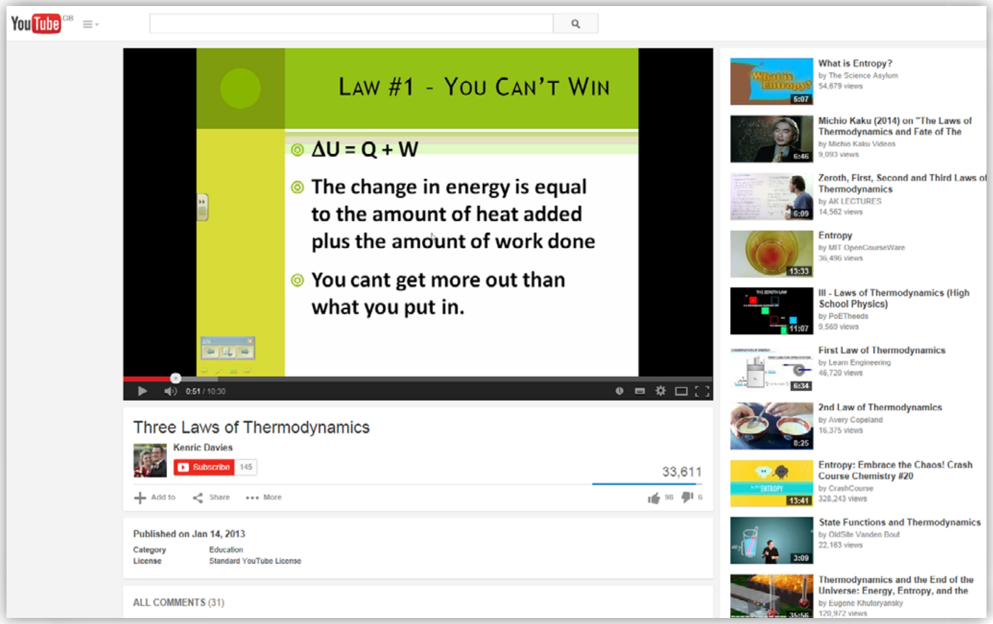
Description:
An explanation with worked examples of latent heat.

Supports:
OCR Cambridge Technicals in Engineering Level 3
Unit 2

Cost:
Free

Format:
Web page

First and Second Law of Thermodynamics



https://www.youtube.com/watch?v=xdRtWK1_2Eo

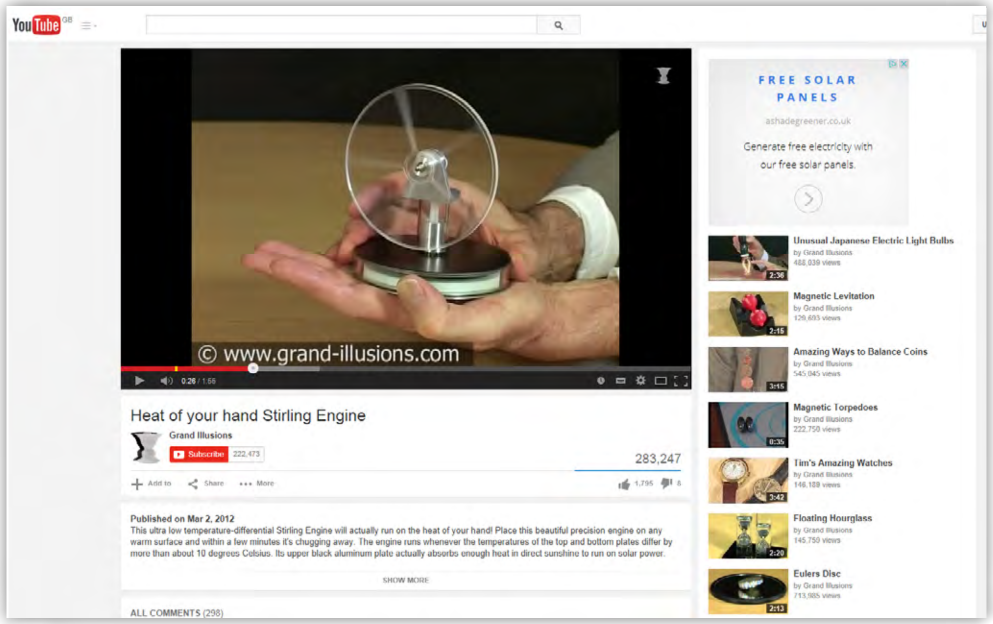
Description:
A YouTube tutorial explaining the first and second laws of thermodynamics. Makes reference to how a heat engine works.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Youtube video

Heat of your hand Stirling Engine



https://www.youtube.com/watch?v=zCGTNArwJ0s

Description:
YouTube video showing hand held Stirling Engine working. The Stirling Engine works on the principle of heat transfer generating work energy – and is a good demonstration of the laws of thermodynamics.

Supports:
OCR Cambridge Technicals in Engineering Level 3 Unit 2

Cost:
Free

Format:
Youtube video

Cambridge TECHNICALS

Contact us

Staff at the OCR Customer Contact Centre are available to take your call between 8am and 5.30pm, Monday to Friday.

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