



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.

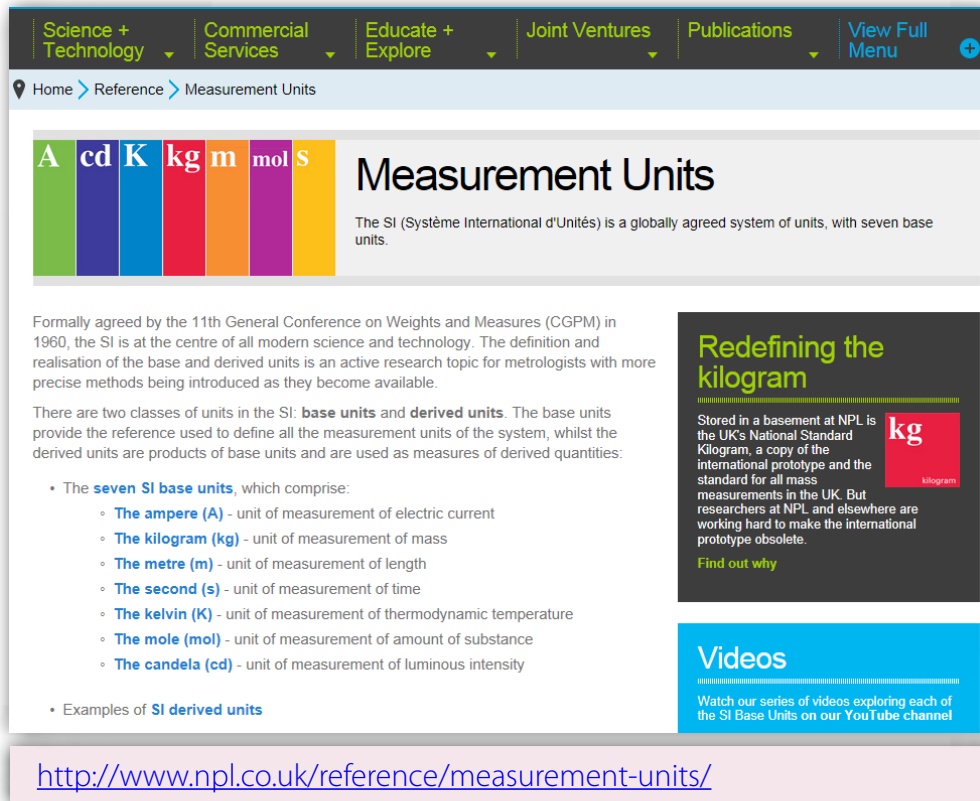
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Measurement units – SI Units



The screenshot shows the NPL website's 'Measurement Units' page. At the top is a navigation bar with links: Science + Technology, Commercial Services, Educate + Explore, Joint Ventures, Publications, and View Full Menu. Below this is a breadcrumb trail: Home > Reference > Measurement Units. The main heading is 'Measurement Units' with a subtext: 'The SI (Système International d'Unités) is a globally agreed system of units, with seven base units.' A row of colored boxes represents the base units: A (ampere), cd (candela), K (kelvin), kg (kilogram), m (metre), mol (mole), and s (second). The text explains that the SI was formally agreed by the 11th General Conference on Weights and Measures (CGPM) in 1960. It then lists the seven SI base units with their symbols and what they measure. A sidebar on the right features a section titled 'Redefining the kilogram' with a 'kg' icon and text about the UK's National Standard Kilogram and the international prototype. Below this is a 'Videos' section with a link to watch a series of videos on the SI Base Units on the YouTube channel. At the bottom of the page is a URL bar showing the link: <http://www.npl.co.uk/reference/measurement-units/>

Science + Technology Commercial Services Educate + Explore Joint Ventures Publications View Full Menu

Home > Reference > Measurement Units

Measurement Units

The SI (Système International d'Unités) is a globally agreed system of units, with seven base units.

Formally agreed by the 11th General Conference on Weights and Measures (CGPM) in 1960, the SI is at the centre of all modern science and technology. The definition and realisation of the base and derived units is an active research topic for metrologists with more precise methods being introduced as they become available.

There are two classes of units in the SI: **base units** and **derived units**. The base units provide the reference used to define all the measurement units of the system, whilst the derived units are products of base units and are used as measures of derived quantities:

- The **seven SI base units**, which comprise:
 - The **ampere (A)** - unit of measurement of electric current
 - The **kilogram (kg)** - unit of measurement of mass
 - The **metre (m)** - unit of measurement of length
 - The **second (s)** - unit of measurement of time
 - The **kelvin (K)** - unit of measurement of thermodynamic temperature
 - The **mole (mol)** - unit of measurement of amount of substance
 - The **candela (cd)** - unit of measurement of luminous intensity
- Examples of **SI derived units**

Redefining the kilogram

Stored in a basement at NPL is the UK's National Standard Kilogram, a copy of the international prototype and the standard for all mass measurements in the UK. But researchers at NPL and elsewhere are working hard to make the international prototype obsolete.

[Find out why](#)

Videos

Watch our series of videos exploring each of the SI Base Units on our YouTube channel

<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

Accuracy and Precision
They mean slightly different things!

Accuracy
Accuracy is how close a measured value is to the **actual (true) value**.

Precision
Precision is how close the measured values are **to each other**.

Examples of Precision and Accuracy:



Low Accuracy High Precision	High Accuracy Low Precision	High Accuracy High Precision
--------------------------------	--------------------------------	---------------------------------

<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?

Edword Simpson posted on July 31, 2013 | [Comment](#) | 15613 views

[f Facebook](#) [Twitter](#) [g+ Google+](#) [in LinkedIn](#) [+ More](#)



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



Resources Link



OCR
Oxford Cambridge and RSA

7

Errors in Measurement

Home Numbers Algebra Geometry Data Measure Puzzles Games Dictionary Worksheets

1 Tip to Lose Stomach Fat
Erase 15kg of unwanted belly fat without dieting. Use this 1 trick!

Errors in Measurement

Error?
No ... you didn't measure it **wrong** ... this is about **accuracy**.

Measuring instruments are not exact!

Degree of Accuracy
Accuracy depends on the instrument you are measuring with. But as a general rule:

<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

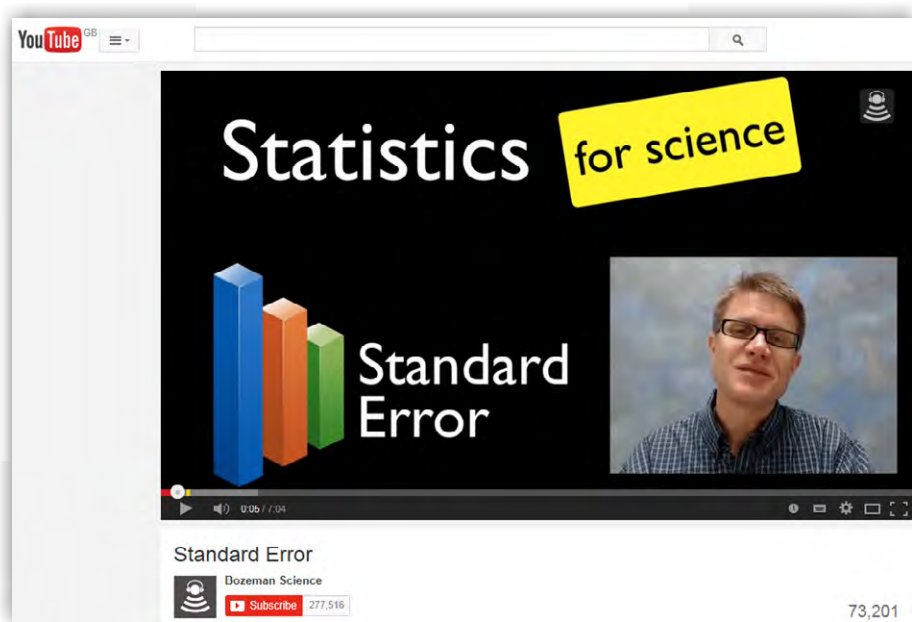
Cost:

Free

Format:

Youtube video

Standard Error



<http://www.youtube.com/watch?v=BwYj69LAQQI>

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

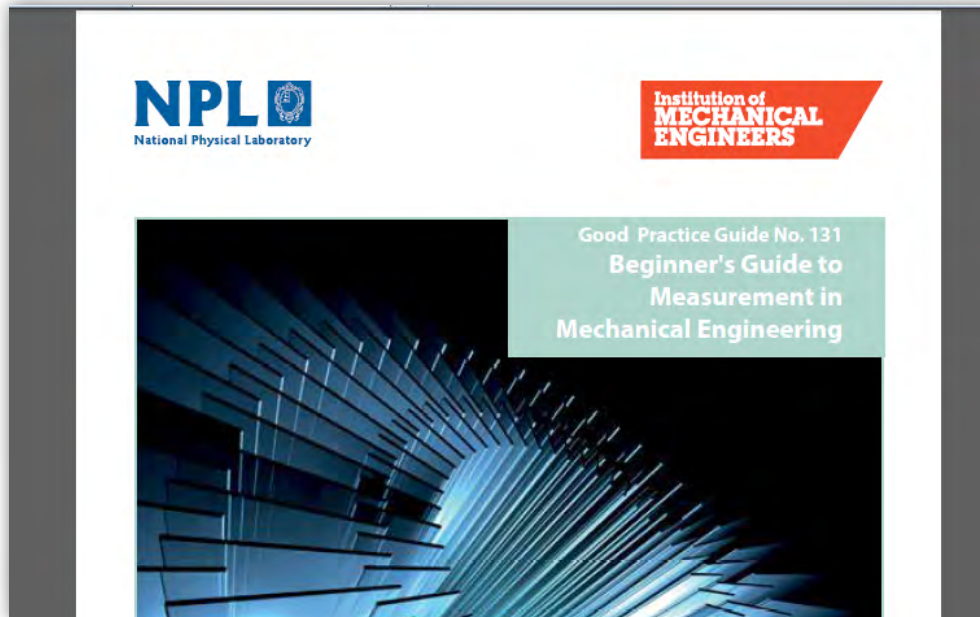
Cost:

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

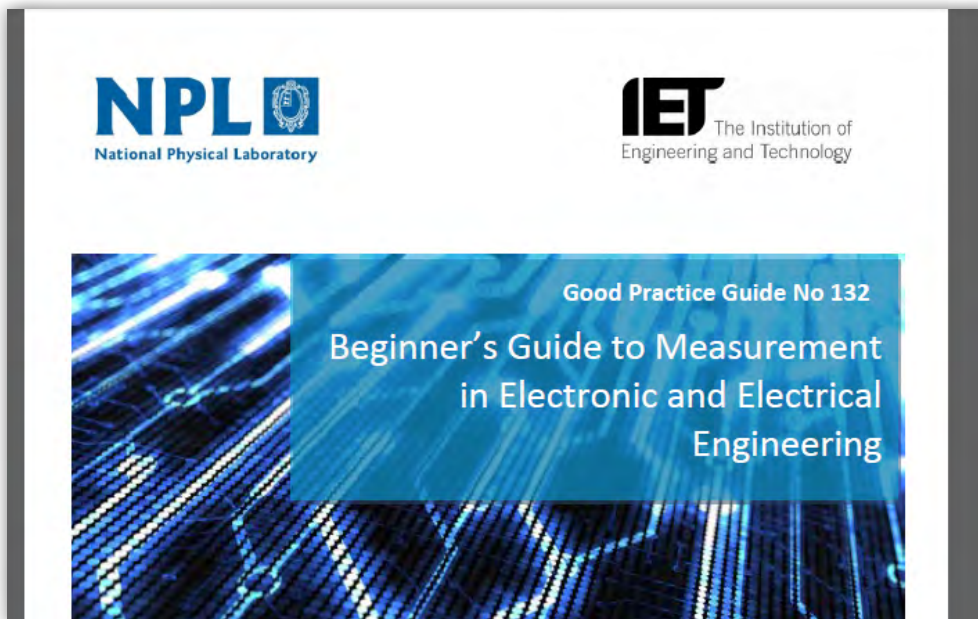
Cost:

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 of 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

PHYSICS

One-dimensional motion

In this tutorial we begin to explore ideas of velocity and acceleration. We do exciting things like throw things off of cliffs (far safer on paper than in real life) and see how high a ball will fly in the air.

ALL CONTENT IN "ONE DIMENSIONAL MOTION"

Displacement, velocity and time

This tutorial is the backbone of your understanding of kinematics (i.e., the motion of objects). You might already know that distance = rate $\times$ time. This tutorial essentially reviews that idea with a vector lens (we introduce you to vectors here as well). So strap your bolts (actually this might not be necessary since we don't plan on decelerating in this tutorial) and prepare for a gentle ride of foundational physics knowledge.

- Introduction to vectors and scalars
- Calculating average velocity or speed
- Solving for time
- Displacement from time and velocity example

Acceleration

In a world full of unbalanced forces (which you learn more about when you study Newton's laws), you will have acceleration (which is the rate in change of velocity). Whether you're thinking about how fast a Porsche can get to 60mph or how long it takes for a passenger plane to get to the necessary speed for flight, this tutorial will help.

- Acceleration
- Airbus A380 take-off time
- Airbus A380 take-off distance
- Why distance is area under velocity-time line

<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

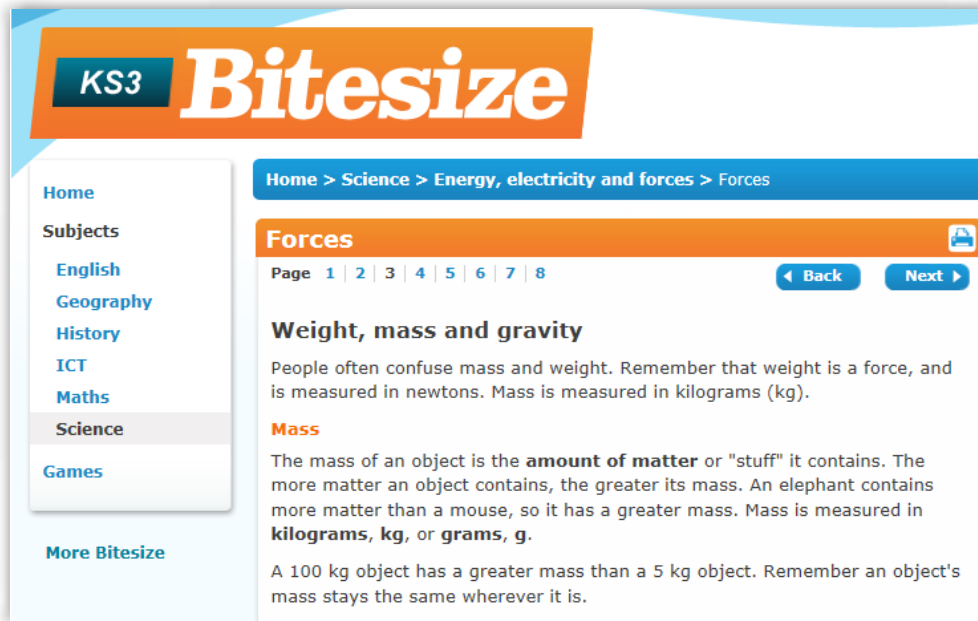
Cost:

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

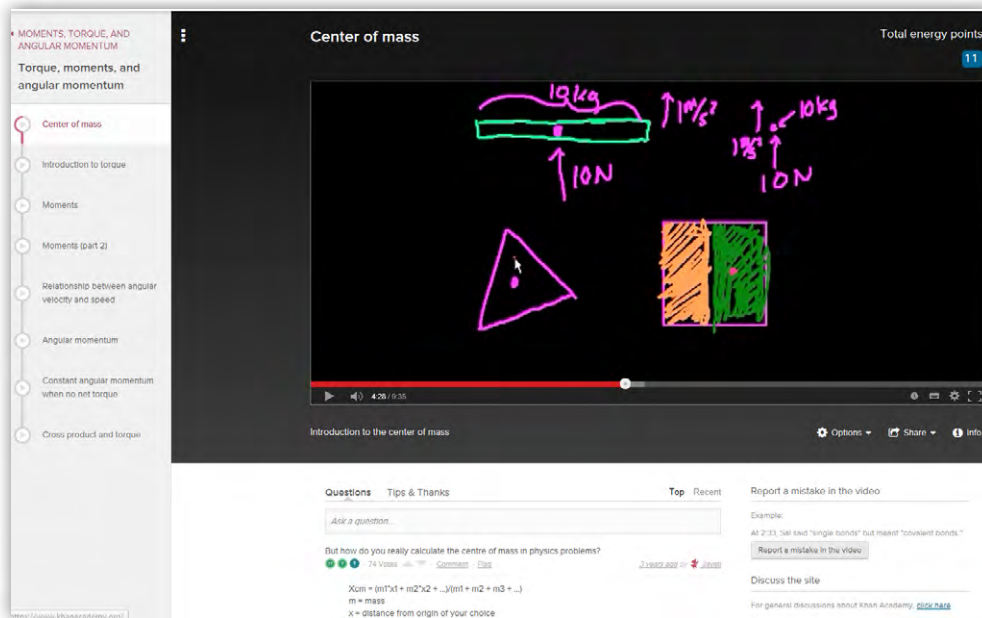
Cost:

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

schoolphysics

HOME > AGE 16-19 > MECHANICS > DYNAMICS > FORCE WORK ENERGY AND POWER EQUATIONS

Force, work energy and power – equations

Work done = Energy transformed = Force $\times$ displacement = $F \cos \alpha$
(This is an example of two vectors being multiplied together to give a scalar)

Fire-fighter sliding down a pole

$$mgh - \frac{1}{2}mv^2 = Fh$$

Climber sliding down a rope

$$mgh - \frac{1}{2}mv^2 = Fh$$

Parachutist

$$mgh - \frac{1}{2}mv^2 = Fh$$

with the parachute open the parachutist falls at their terminal velocity and so:

$$\text{At terminal velocity: Drag force (F) = mg}$$

Skier on a slope

$$mgh - \frac{1}{2}mv^2 = F_s = F_s \sin A$$

where A is the angle of the slope with the horizontal

Car braking to a stop

$$\frac{1}{2}mv^2 = F_s$$


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 1 - DC Basic Concepts Of Electricity Conventional versus electron flow

Conventional versus electron flow

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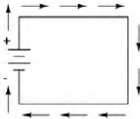
"The nice thing about standards is that there are so many of them to choose from."
Andrew S. Tanenbaum, computer science professor

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*:

Conventional flow notation



Electric charge moves from the positive (surplus) side of the battery to the negative (deficiency) side.

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

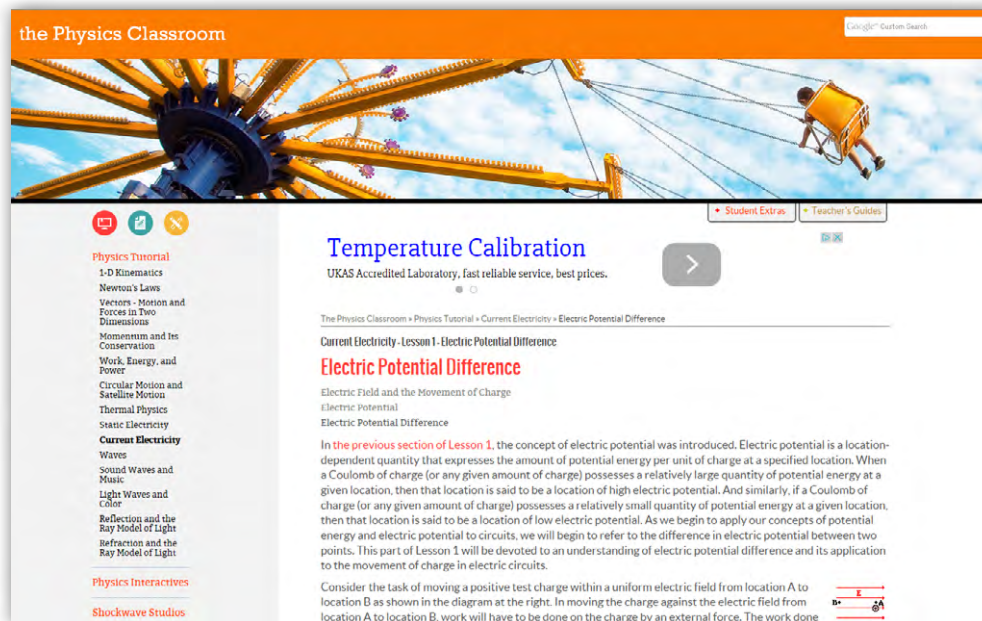
Cost:

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 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

Table of Contents

- How voltage, current, and resistance relate ←
- An analogy for Ohm's Law
- Power in electric circuits
- Calculating electric power
- Resistors
- Nonlinear conduction
- Circuit wiring
- Polarity of voltage drops
- Computer simulation of electric circuits
- Contributors

PDF Version

Recently Viewed

- Conventional versus electron flow

Volume 1: DC · Ohm's Law · How voltage, current, and resistance relate

How voltage, current, and resistance relate

Meet your new WebEx.

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 the ohm after the German Simon-Denis Ohm.

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:

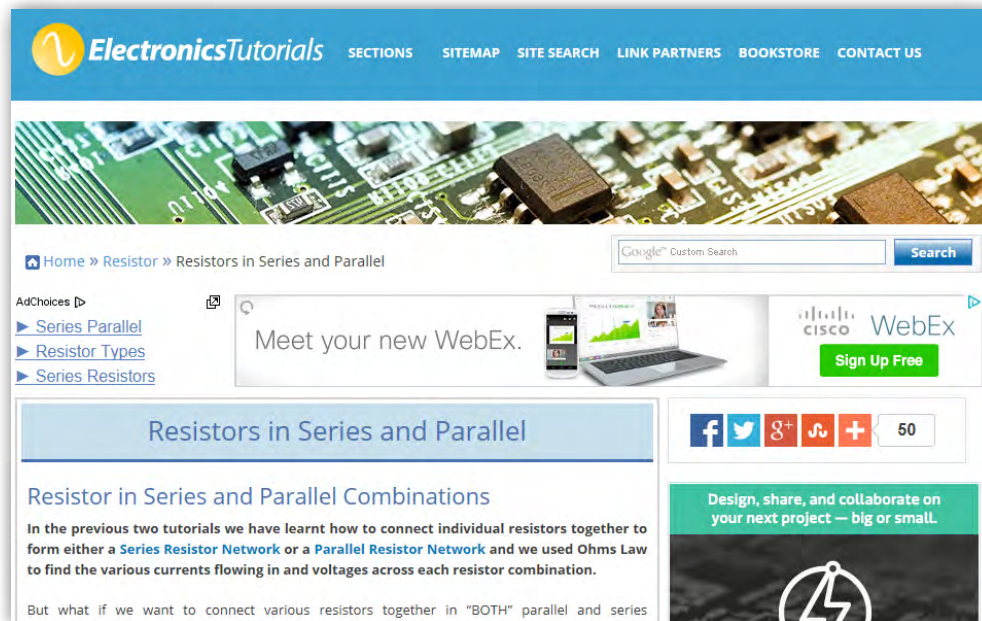
Free

Format:

Web page

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

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

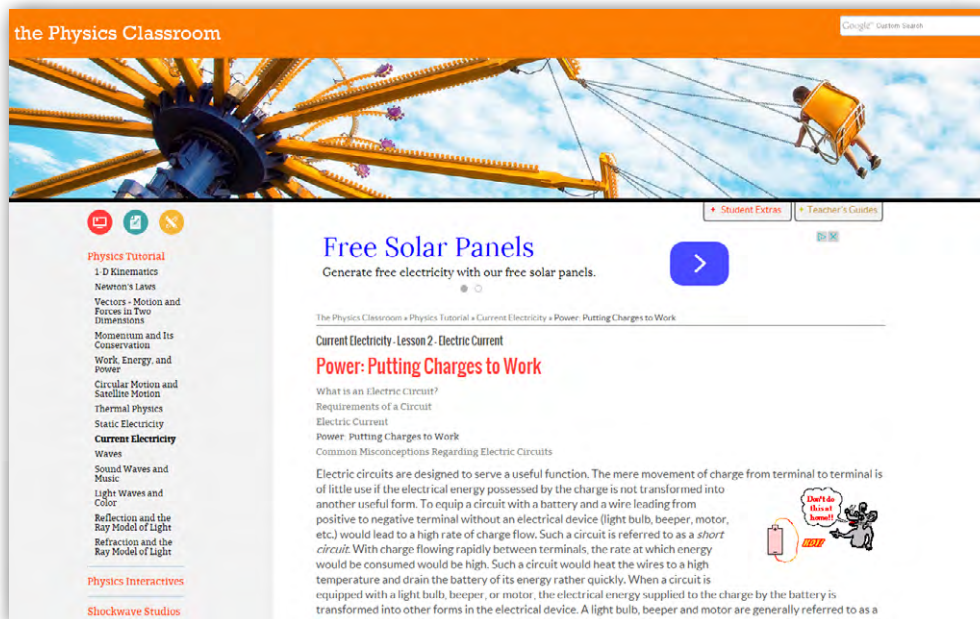
Cost:

Free

Format:

Web page

Energy and Power



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

2. Electric current

Resistance and resistivity

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)	$\Omega \text{ m}$ (ohm metre)
Resistance	R	Ω

The resistivity of pure copper is $1.7 \times 10^{-8} \Omega \text{ m}$.

Notice that this is a very small number – 0.000 000 017 $\Omega \text{ m}$. 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 $10^{-8} \Omega \text{ m}$ to more than $10^{16} \Omega \text{ m}$ – more than 24 orders of magnitude. No other property of materials varies over such a wide range.

Metal	Resistivity ($\Omega \text{ m}$)	Material	Resistivity ($\Omega \text{ m}$)
silver	1.6×10^{-8}	carbon	36 to 6000 $\times 10^{-8}$
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}
brass	44.0×10^{-8}	pyrex glass	10^{12}
constantan (alloy)	49.0×10^{-8}	PTFE	10^{12} to 10^{16}
stainless 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
- the resistivity of the material – the greater the resistivity, the greater its resistance

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

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

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

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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.

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

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

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:

Energy stored = - integral $[v dq] = \frac{1}{2} \frac{Q^2}{C}$
(taking the integral from 0 to Q)

Using $Q = CV$ gives some alternative formulae:

Energy stored in a capacitor = $\frac{1}{2} \frac{Q^2}{C} = \frac{1}{2} CV^2 = \frac{1}{2} QV$

If the plates had been moved so as to increase the area but keep their separation the same the new energy would be: Energy = $\frac{1}{2} \frac{Q^2}{C}$
 Q would be constant but C would increase ($C = \epsilon A/d$ with a bigger area) and so the overall energy would decrease. $C = \epsilon A/d = Q/V$.
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 = $\frac{1}{2} CV^2 = \frac{1}{2} \epsilon_0 A V^2 / d = [8.85 \times 10^{-12} \times 25 \times 10^{-4} \times 10^3] / 2 \times 10^{-3} = 1.1 \times 10^{-7} \text{ J}$

(b) New plate separation = 0.002 m ; potential across plates is still 100 V .
New energy = $0.5 \times \text{original energy} = 0.55 \times 10^{-7} \text{ J}$
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 = $\frac{1}{2} \frac{Q^2}{C} = \frac{1}{2} \frac{Q^2}{\epsilon A/d} = \frac{1}{2} \frac{Q^2 d}{\epsilon A}$ and since d is doubled the energy will be doubled to $2.2 \times 10^{-7} \text{ J}$.

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

The energy stored in a capacitor used for camera flash unit is about 1 J . This is released in around 1 ms giving an output power of 1 kW .

Description:

Description with equations of energy stored in a capacitor.

Supports:

OCR Cambridge Technicals in Engineering Level 3
Unit 2

Cost:

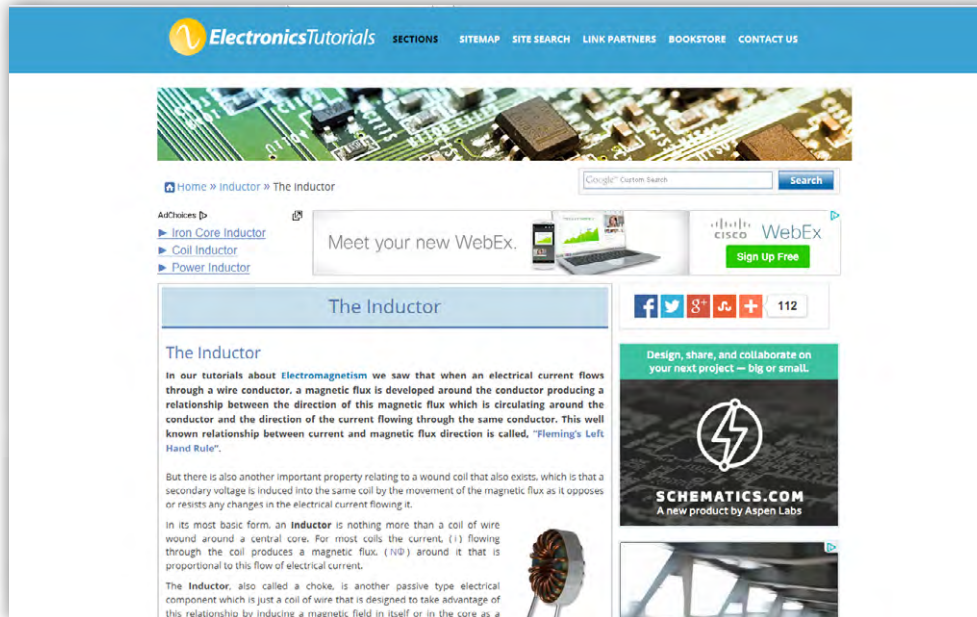
Free

Format:

Web page

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

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

Physics Complete

Physics right from very basics to advanced topics, materials for IIT-JEE, AIEEE and all physics exams preparation.

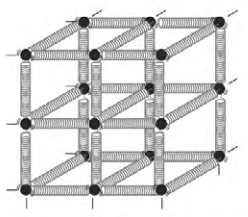
Venkats Academy Classical Mechanics Properties of Matter Heat and Thermodynamics Waves and Oscillations Privacy Policy

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

- Mechanical Property Bulk modulus
- Fluid Flow and Pascal's Law
- Newton Laws and Free body diagram
- What is a Vector?
- Dimensional Formula of Physical Quantities

New at Physics Complete

- Mechanics Kinematics Introduction
- How to Round Off Number for Physics Calculation
- Errors and Significant Figures in Physics
- Errors and Approximation in Physics part two
- Privacy Policy

Physics Topics

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

<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

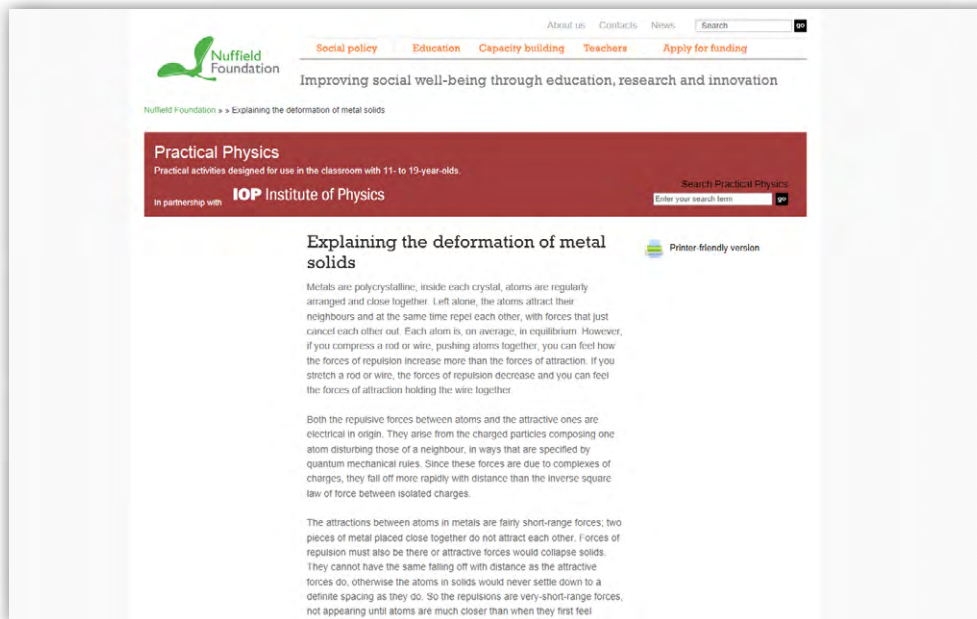
Cost:

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)

schoolphysics

HOME > AGE 16-19 > PROPERTIES OF MATTER > ELASTICITY > INTERMOLECULAR FORCES

Intermolecular forces

Forces within materials

All materials have internal forces that hold the individual molecules together to form a solid. (You should realise that all these forces are types of the basic electromagnetic force.) The forces in solids are of four types:

- (a) **ionic** - this is the electrostatic attraction of two oppositely charged ions and occurs in crystals such as sodium chloride.
- (b) **covalent** - this force results from electrons being shared between the shells of adjacent atoms as in diamond, silicon and methane.
- (c) **metallic** - this force is due to the free electron cloud that exists in metals such as copper. The electrons move freely between the atoms and are not fixed to any pair of atoms as they are in the covalent bond.
- (d) **van der Waals** - these are electric dipole forces formed by the electron cloud and the nucleus; they operate in all matter and are responsible for the attractive force between molecules in a gas. They can be observed in solid neon, simply because none of the others operate there.

These forces can give an explanation of some of the elastic and thermal properties of a material.

Figure 1 shows how the potential energy of two molecules and the force between them changes with their separation. The force at any point is found from $F = -dV/dr$, where V is the potential energy.

Two forces act between the molecules:

- (a) the repulsive force which predominates at short distances
- (b) the attractive force which predominates at long distances

You can see from the graph that when the molecules are close to each other the repulsive force predominates, while at greater distances the attractive force is larger. The resultant force is:

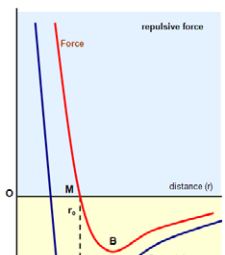
- (a) repulsive from O to M,
- (b) attractive from M to B but increasing with distance, and
- (c) attractive from B to infinity but decreasing with distance.

There is a position where the two forces balance, shown by M on the graph. This is the equilibrium position for molecules in the solid.

The potential energy is a minimum at this point (as would be expected). Any disturbance from this position would produce a force tending to return the molecules to M. The force of attraction between the molecules increases as the molecules are separated from M to B.

The breaking point is at B, since beyond this point the force of attraction decreases with increasing separation.

For a molecule to be completely separated from its neighbour it must gain an amount of energy F , represented by CM on the diagram. The latent heat of vaporisation for the two molecules is CM when there is no residual attractive force. This length also represents the latent heat of vaporisation for the whole material.



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

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

Elastic and plastic deformation

Deformation

Any time a stress is placed on a metal, the metal undergoes a deformation where the material's shape changes either temporarily or permanently. The amount of change the material experiences is due to the amount of stress being placed on the object and the material. A material's yield strength is a measure of how much stress the object can undergo before it begins plastic deformation and is also an excellent representative of a material's load-bearing capabilities.

There are two types of deformations that a material can experience. These are elastic and plastic deformation. When the stress placed on the metal is small, meaning that the stress is less than the yield strength of the material, the metal experiences elastic deformation; the material is distorted temporarily, thus when the stress is removed the material returns to its original shape with no permanent rearrangement of atoms. However, when the stress placed on the metal exceeds the yield strength of that material, plastic deformation occurs. Once the metal experiences plastic deformation its atomic structure and overall shape are permanently rearranged and changed. Once plastic deformation has occurred, the material does not return to its original shape when removed.

In order to discover why plastic deformation occurs, we must look at the atomic makeup of metals. Most metals are crystalline solids which contain orderly arrangement of atoms. These atoms exist in a lattice form which varies from material to material. Structure exist smooth surfaces between layers of atoms. Slipping, which is the most common reason for plastic deformation, occurs when the sheets of atoms slide across each other causing bonds to break. Once the original bonds have been broken, the atoms form new bonds forever changing the shape of the material.

Slipping is due to a couple of reasons. First, whenever a metallic bond relies on the relatively non-directional sharing of electrons, the atoms have a tendency to slip under little stress because relative position is not a major factor in keeping the bonds together. Second, metallic crystals are not perfect, therefore sometimes atoms are missing causing lines of defective bonding, known as dislocations, as seen in the following illustration.

Dislocations have a tendency to move easily in metals due to the de-localized bonding, thus the sheet slips gradually resulting in plastic deformation. The following image illustrates how a deformation can move through a metal.

<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 of 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

The ability of a material to resist penetration, wear and tear and indentation.



<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

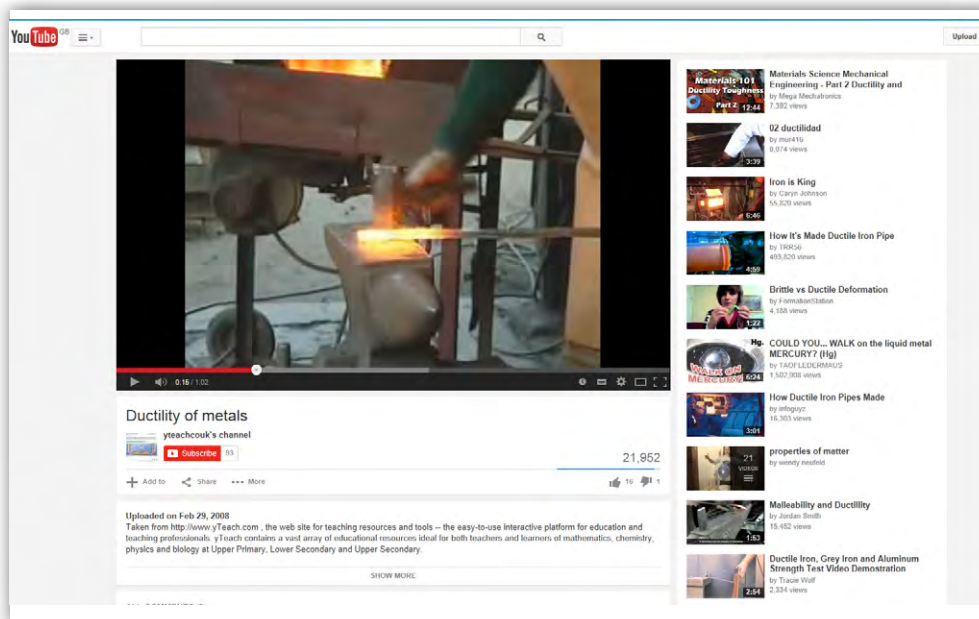
Cost:

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

The screenshot shows a webpage with a navigation bar at the top containing 'copper and electricity', '2. Electric current', and 'Drift velocity'. The main content is titled 'Drift velocity and current' and explains how free electrons move in a wire to produce a current. It includes a diagram of a wire with free electrons and a caption: 'Figure 2.6 All the electrons in a cylinder with volume, $V = A \times l$ flow past a point in a time t .' The text defines 'Current' as the rate at which electric charge flows past a point in a circuit. It then derives the formula for current $I = n A v Q$ by considering the volume of the cylinder, the number of electrons, and the charge they carry. The final formula is boxed: $I = n A v Q$. Below this, it discusses 'Resistivity and charge density' and 'How fast do electrons drift?'. A small table at the bottom left lists values for copper: $n = 8.5 \times 10^{28}$ per m^3 and $Q = 1.6 \times 10^{-19}C$.

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

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

Stress and Strain

The screenshot shows the PhysicsNet.co.uk website. The header includes navigation links: HOME, GCSE, A-LEVEL, GLOSSARY, LINKS, BLOG, CONTACT, COPYRIGHT, MAIL, VLE, and a SUBSCRIBE button. The main title is "PhysicsNet.co.uk" with a cartoon character logo. The page is titled "Stress & Strain". Under the "Stress" section, it defines stress as force per unit area and mentions breaking stress and ultimate tensile stress. It also defines tensile and compression forces. The formula for stress is given as $stress = \frac{force}{area}$ and $stress = \frac{F}{A}$. A note at the bottom states: "stress = stress measured in Nm^{-2} or pascals (Pa)" and "F = force in newtons (N)". The right sidebar contains a search bar, links to "Physics Careers", "University Courses", and "Why take Physics?", and social media icons for Twitter and YouTube.

<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

Hooke's Law

The screenshot shows the GCSE Bitesize website interface. The top navigation bar includes 'GCSE Bitesize', 'BBC Radio 1', and 'BBC 1Xtra'. A left sidebar lists various subjects like Art & Design, Business Studies, Design & Technology, DfA, Drama, English, English Literature, French, Geography, German, History, ICT, Irish, Maths, Music, Physical Education, Religious Studies, Science (highlighted), Spanish, Welsh 2nd Language, Audio, and Games. The main content area is titled 'Science' and 'Forces and elasticity'. It features a 'Print' button, a 'Page: 1 | 2' indicator, and a 'Back' link. The title 'Hooke's Law' is prominently displayed. The text explains that when an elastic object like a spring is stretched, the increased length is called its extension, and this extension is directly proportional to the force applied. The formula $F = k \times e$ is shown in a yellow box. Below it, definitions are provided: F is force in newtons (N), k is the 'spring constant' in newtons per metre (N/m), and e is the extension in metres (m). A paragraph states that the equation works as long as the elastic limit is not exceeded. A section titled 'The spring constant' explains that k varies by object and material, found by experiment, and mentions 'slotted masses'. At the bottom, a graph shows a straight line starting from the origin on a grid, representing the linear relationship between force and extension.

Description:

Basic introduction to Hooke's Law.

Supports:

OCR Cambridge Technicals in Engineering Level 3
Unit 2

Cost:

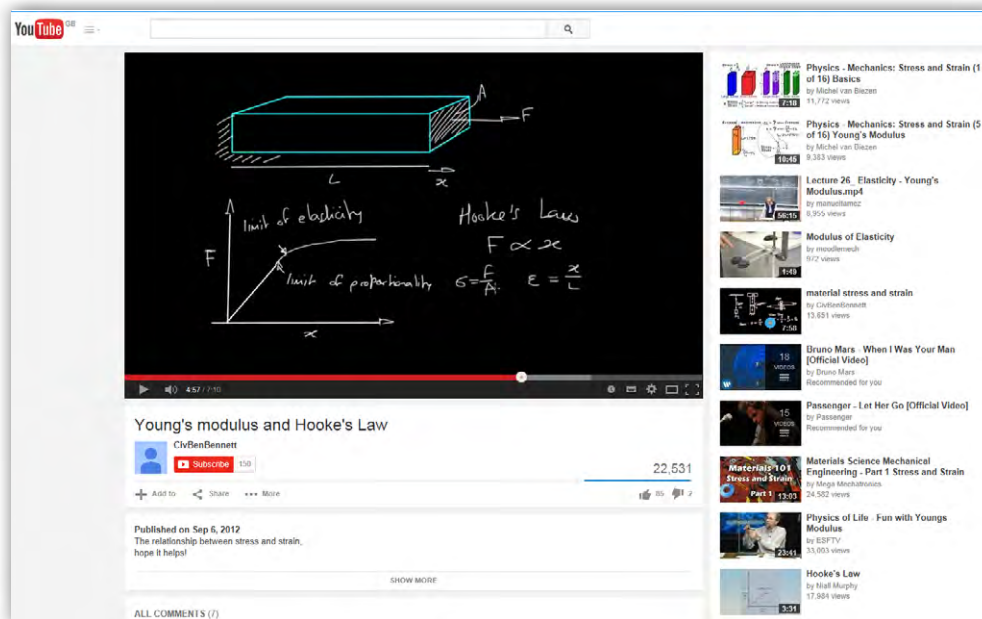
Free

Format:

Web page

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

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

The screenshot shows a web page from 'School for Champions' with a blue header. The main content area is titled 'Pressure is Force per Unit Area' by Ron Kurtus. It includes a definition of pressure, a list of questions, and a sidebar with 'Force topics' and 'Work and Force'. A Norton security banner is visible in the middle of the page.

Pressure is Force per Unit Area
by Ron Kurtus (revised 18 March 2006)

Pressure is the force on an object that is spread over a surface area. The equation for pressure is the force divided by the area where the force is applied. Although this measurement is straightforward when a solid is pushing on a solid, the case of a solid pushing on a liquid or gas requires that the fluid be confined in a container. The force can also be created by the weight of an object.

Questions you may have include:

- What is the pressure when a solid pushes on another solid?
- What happens when a solid pushes on a confined fluid?
- What happens when the force comes from gravity?

This lesson will answer those questions. Useful tool: [Units Conversion](#)

Force topics
[Characteristics of Force](#)
[Units of Force](#)
[Force Affects Motion](#)
[Force and Torque](#)
[Mysterious Force at a Distance](#)
[Centrifugal Force](#)
[Centrifugal Force Caused by Inertia](#)
[Fundamental Forces Act at a Distance](#)
[Pressure is Force per Unit Area](#)

Work and Force
[Work is a Result of Force](#)
[Relationship between Work and Energy](#)
[Work Can be Change in Kinetic Energy](#)

Force of Gravity
[Overview of the Force of Gravity](#)
[Overview of Gravitation](#)
[Force of Friction](#)

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

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

Fluid Statics – pressure in fluids



<https://www.youtube.com/watch?v=mzjAla3H1Q>

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



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

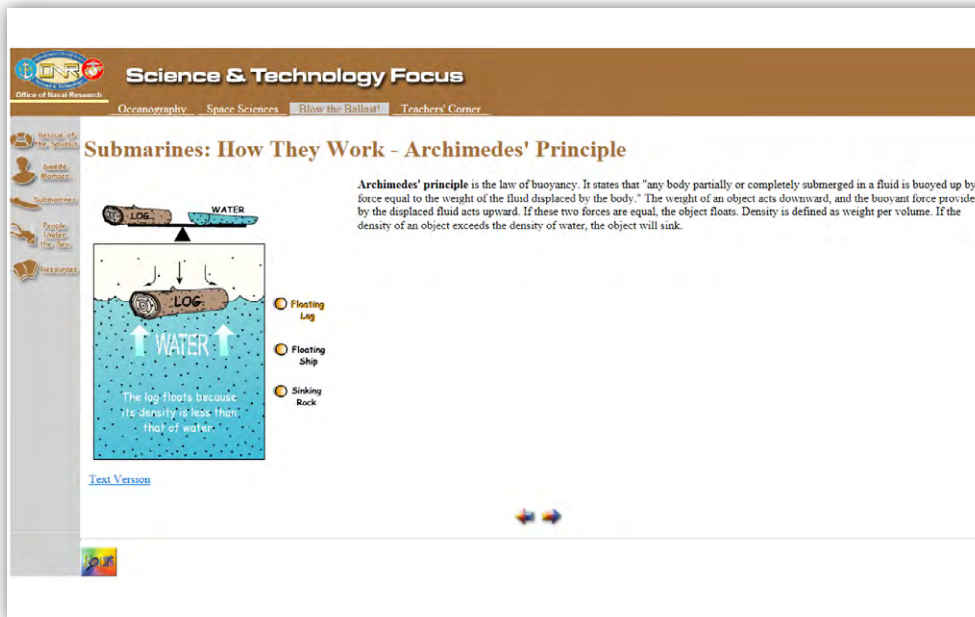
Cost:

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

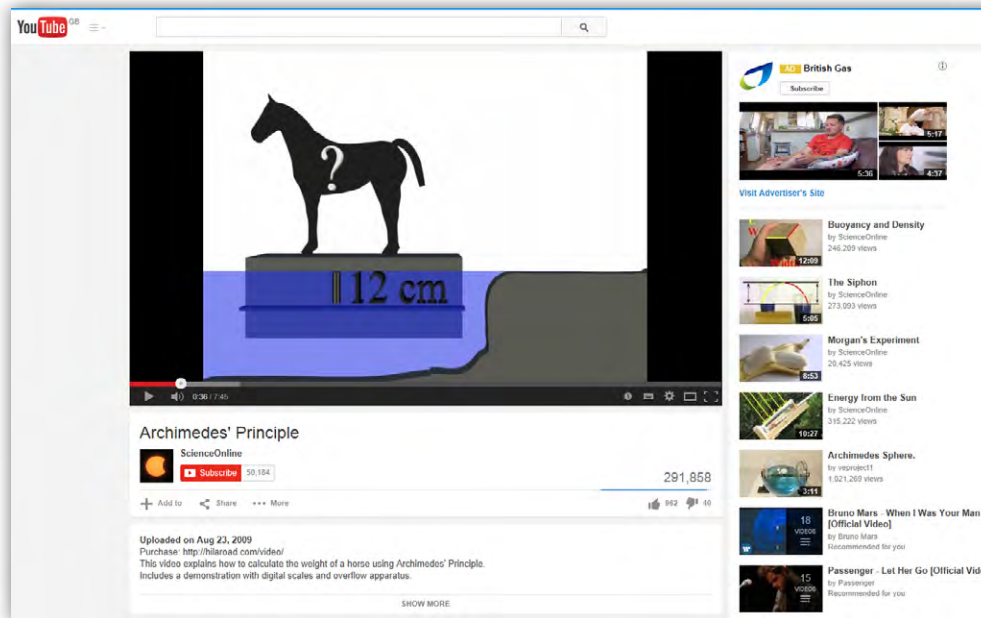
Cost:

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

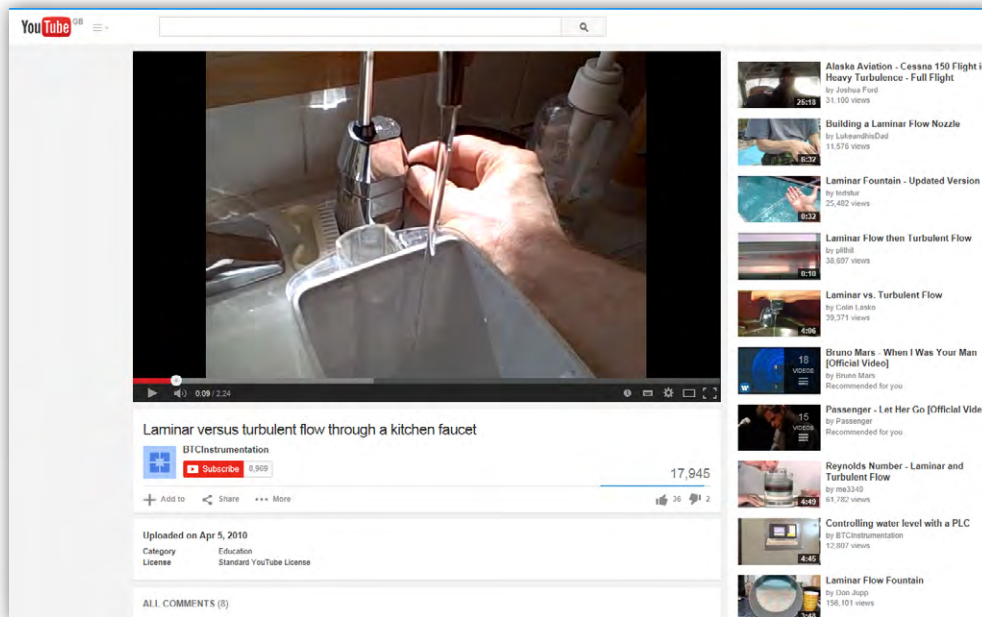
Cost:

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

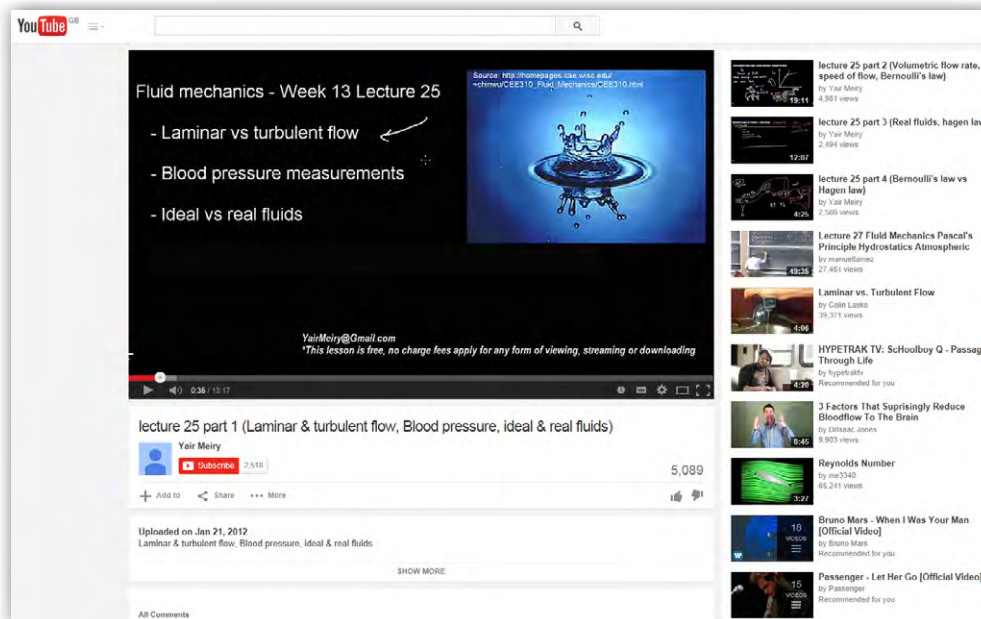
Cost:

Free

Format:

YouTube video

Laminar and Turbulent Flow – Ideal and Real Fluids



<https://www.youtube.com/watch?v=Q2cpuJlWW-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

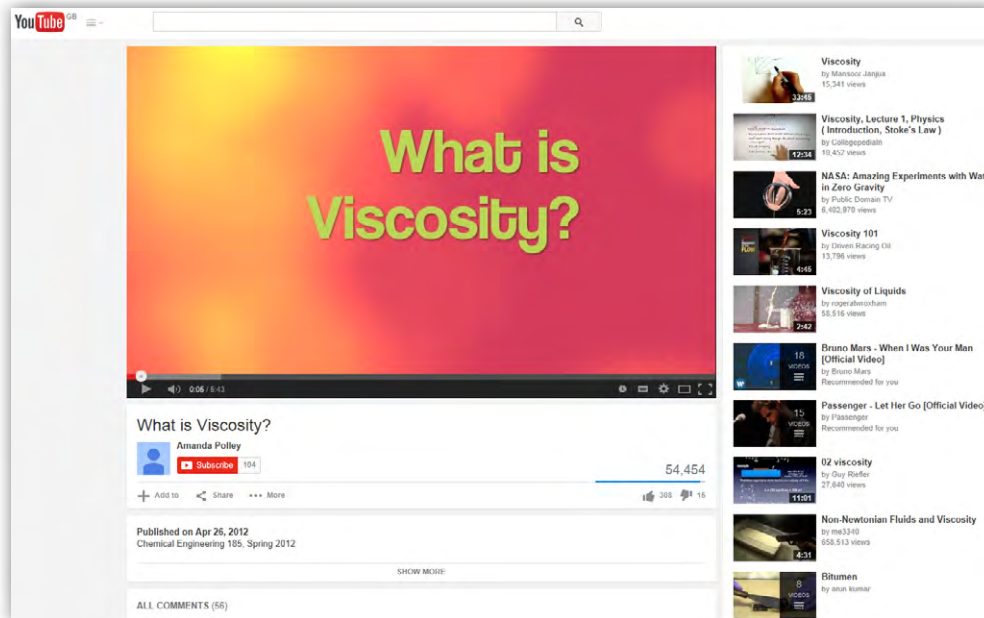
Cost:

Free

Format:

YouTube video

What is viscosity?



<http://www.youtube.com/watch?v=1AESWxko4nl>

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

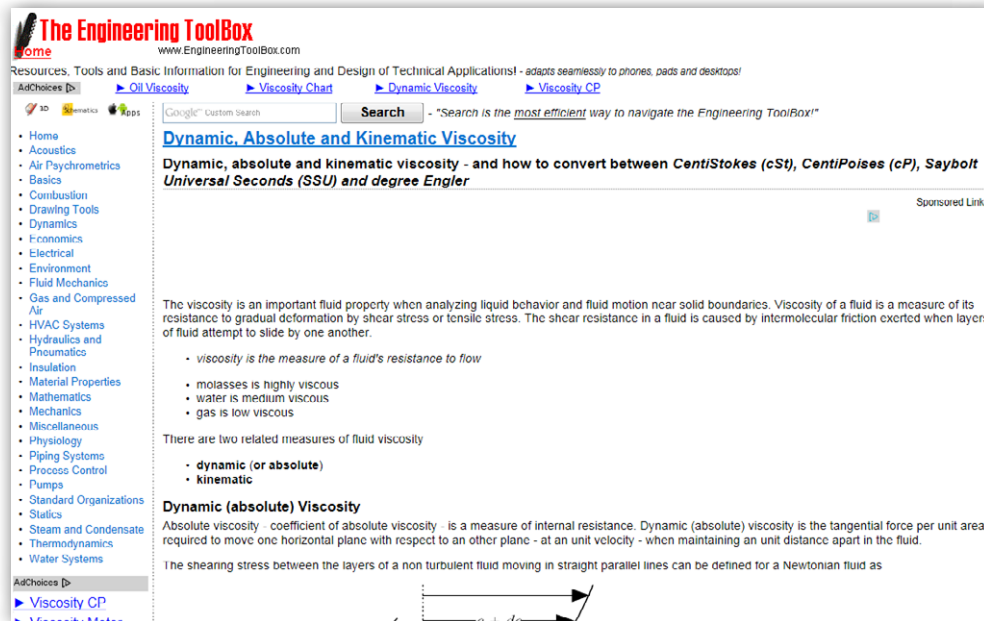
Cost:

Free

Format:

YouTube video

Dynamic (absolute) and Kinematic Viscosity



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

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

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.

Does a glass of water sitting on a table have any energy?

[Index](#)
[Internal energy concepts](#)

U is the most common symbol used for internal energy.

Related energy quantities which are particularly useful in chemical thermodynamics

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

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

Absolute temperature and the Kelvin scale

PHYSICAL PROCESSES

Gas phase

- Absolute temperature and the kelvin scale
- Pressure and the simple mercury barometer
- Definition of an ideal gas, ideal gas law
- Derivation of gas constants using molar volume and STP
- Boyle's law
- Charles's law
- Avogadro's law
- Real gases and the van der Waals equation
- Partial pressure
- Gas phase questions

Next section: Kinetic molecular theory of gases

Absolute temperature and the kelvin scale

Total energy points 18

TEMPERATURE $\rightarrow KE = TEMPERATURE$

KELVIN CELSIUS FAHRENHEIT

BOILING FREEZING 0°C 100°C 0°F 212°F

2:22 / 10:13

Options Share Info

Questions Tips & Thanks Top Recent

Ask a question

Why do the Fahrenheit and Celsius scales have a common temp of -40 degrees? Is it possible that they have other equivalence points/further Fahrenheit = Celsius further in both directions?

2 Views 0 Up 0 Down 0 Flag 0 Mark as a problem 0 Add

no.

Report a mistake in the video

Example

At 2:22, the said "unique border" but meant "constant border."

Report a mistake in the video

Discuss the site

For general discussions about Khan Academy, [click here](#)

<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

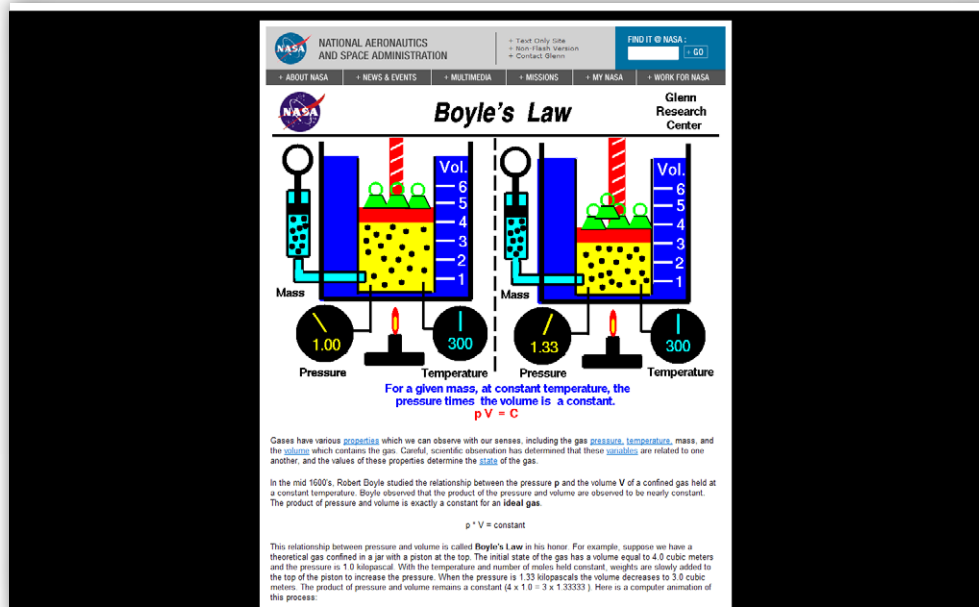
Cost:

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 Boyle's Law.

Supports:

OCR Cambridge Technicals in Engineering Level 3
Unit 2

Cost:

Free

Format:

Webpage

Charles' Law

NASA NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Charles and Gay-Lussac's Law

Glenn Research Center

For a given mass, at constant pressure, the volume is directly proportional to the temperature

$$V = CT$$

Gas have various properties that we can observe with our senses, including the gas pressure, temperature (T), mass, and the volume (V) that contains the gas. Careful, scientific observation has determined that these variables are related to one another and that the values of these properties determine the state of the gas.

The relationship between temperature and volume, at a constant number of moles and pressure, is called Charles and Gay-Lussac's Law in honor of the two French scientists who first investigated this relationship. Charles did the original work, which was verified by Gay-Lussac. They observed that if the pressure is held constant, the volume V is equal to a constant times the temperature T.

$$V = \text{constant} \times T$$

For example, suppose we have a theoretical gas confined in a jar with a piston at the top. The initial state of the gas has a volume equal to 4.0 cubic meters, and the temperature is 300 Kelvin. With the pressure and number of moles held constant, the burner has been turned off and the gas is allowed to cool to 225 Kelvin. (In an actual experiment, a cryogenic ice bath

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

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

Pressure Law

The screenshot shows a webpage with a red sidebar on the left and a main content area. The sidebar contains several links: 'This Topic Contains' with sub-links 'The pressure law' and 'The pressure law example'; 'GCSE Physics All Topics' with an icon of a book and pens; 'Feel the love at OVO Energy and save £146' with a 'Switch card now' button; and 'Get a quote and save up to £255'. The main content area has a yellow header 'Pressure and temperature relationship of a gas – The Pressure Law'. Below the header, it states 'The pressure law states:' followed by a quote: 'For a fixed mass of gas, at a constant volume, the pressure (p) is directly proportional to the absolute temperature (T)'. Below the quote, it says 'Pressure $\propto$ Temperature' and 'Pressure / Temperature = constant'. Further down, it says 'The animation below gives an explanation of the Pressure law' and shows a diagram titled 'THE PRESSURE LAW' depicting a 'Sealed cylinder' with gas molecules inside, a 'Thermometer', and a 'Pressure gauge'.

<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

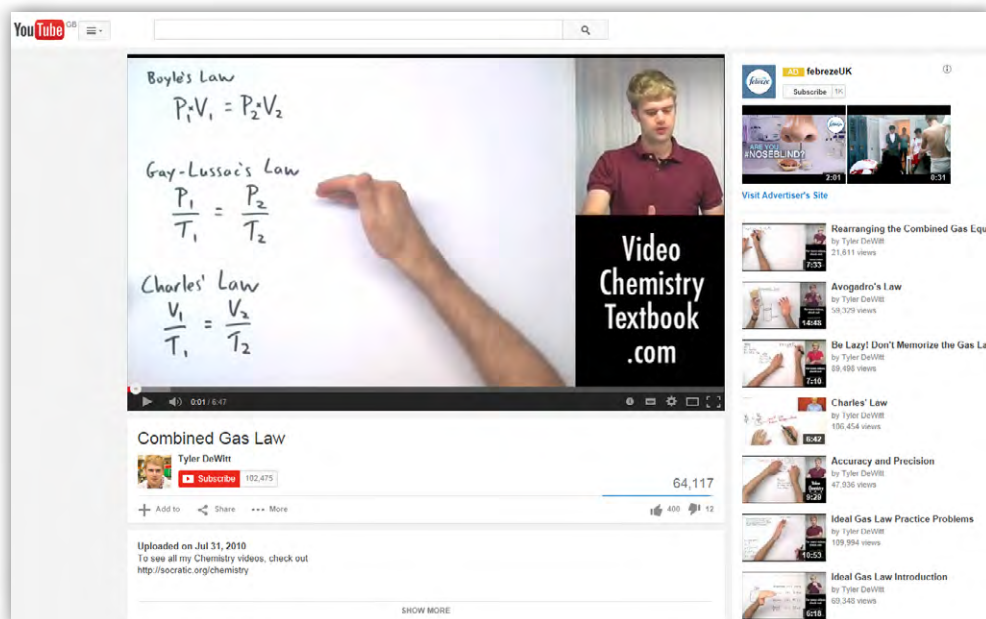
Cost:

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

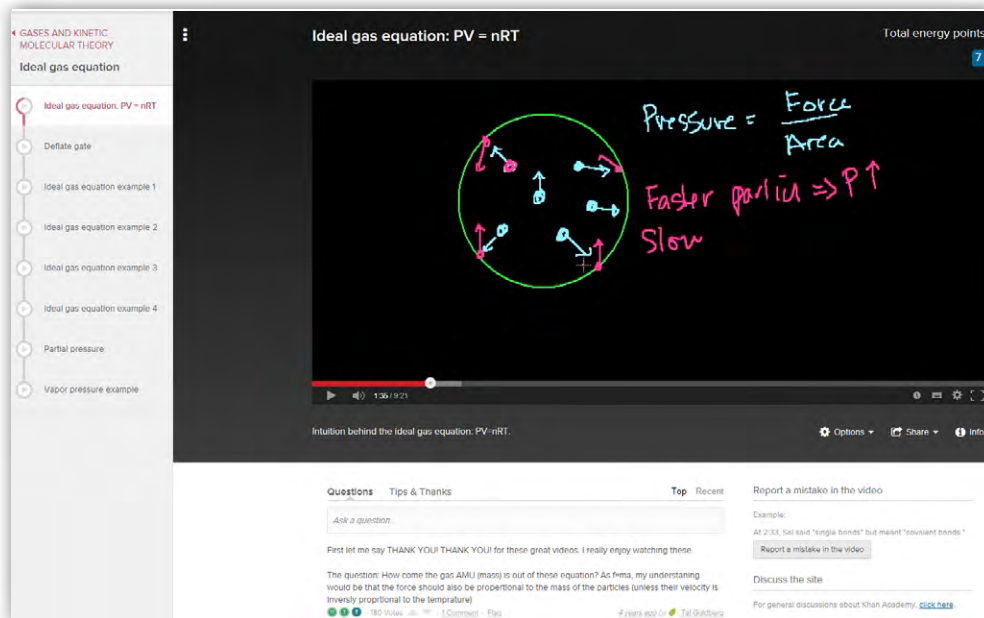
Cost:

Free

Format:

Youtube video

Characteristic (Ideal) Gas Equation



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

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

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

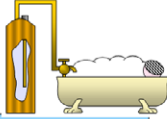
The jam in a sponge pudding stays hotter for longer than the pudding around it
Water is a very good coolant for use in engines
Saucepans are made of materials with a low mass if possible
It takes a long time to heat up enough water to have a hot bath
Houses built with thick stone walls keep warm in winter 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.



Description:

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

Supports:

OCR Cambridge Technicals in Engineering Level 3
Unit 2

Cost:

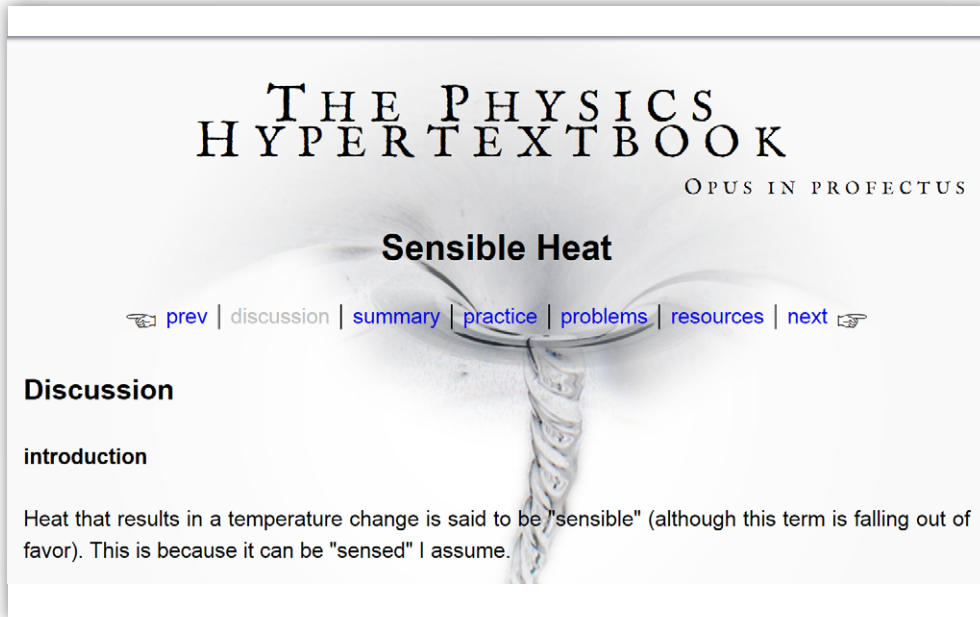
Free

Format:

Web page

[http://www.schoolphysics.co.uk/age14-16/Heat%20energy/Heat%20energy/text/Specific heat capacity and heat energy/index.html?PHPSESSID=b2810791ba27022d9331843c394d05c5](http://www.schoolphysics.co.uk/age14-16/Heat%20energy/Heat%20energy/text/Specific%20heat%20capacity%20and%20heat%20energy/index.html?PHPSESSID=b2810791ba27022d9331843c394d05c5)

Sensible Heatcapacity)



**THE PHYSICS
HYPERTEXTBOOK**
OPUS IN PROPECTUS

Sensible Heat

👉 [prev](#) | [discussion](#) | [summary](#) | [practice](#) | [problems](#) | [resources](#) | [next](#) 👉

Discussion

introduction

Heat that results in a temperature change is said to be "sensible" (although this term is falling out of favor). This is because it can be "sensed" I assume.

<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

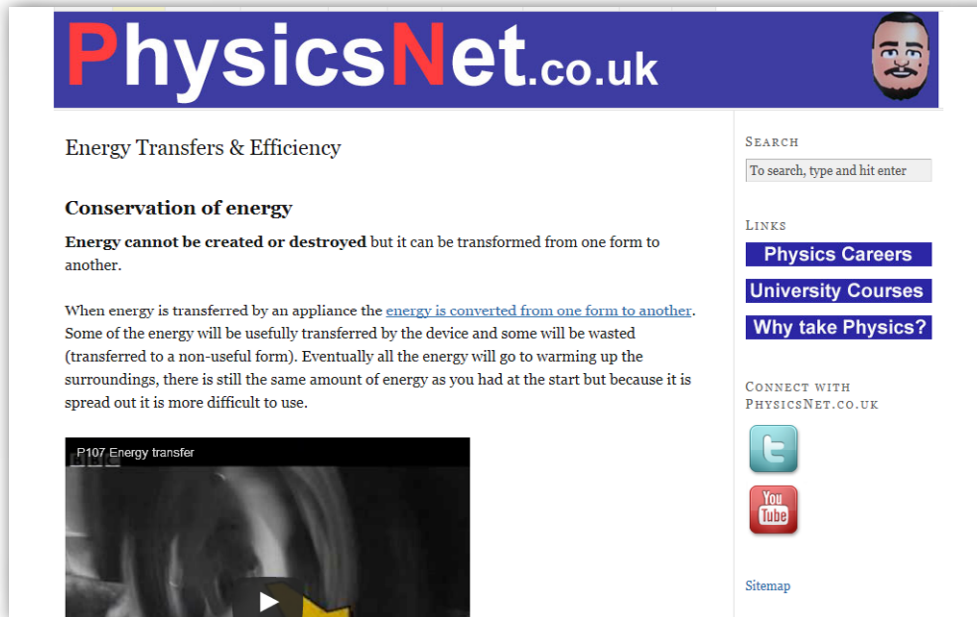
Cost:

Free

Format:

Web page

Efficiency



The screenshot shows the PhysicsNet.co.uk website. The header has the site name in large red and white letters. Below the header, the page title is 'Energy Transfers & Efficiency'. The main content area is titled 'Conservation of energy' and contains text explaining that energy cannot be created or destroyed but can be transformed. It also mentions that energy is converted from one form to another. A video player is embedded at the bottom of the main content area, showing a close-up of a turbine or engine component. On the right side of the page, there is a search bar, a list of links including 'Physics Careers', 'University Courses', and 'Why take Physics?', and social media icons for Twitter and YouTube.

<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

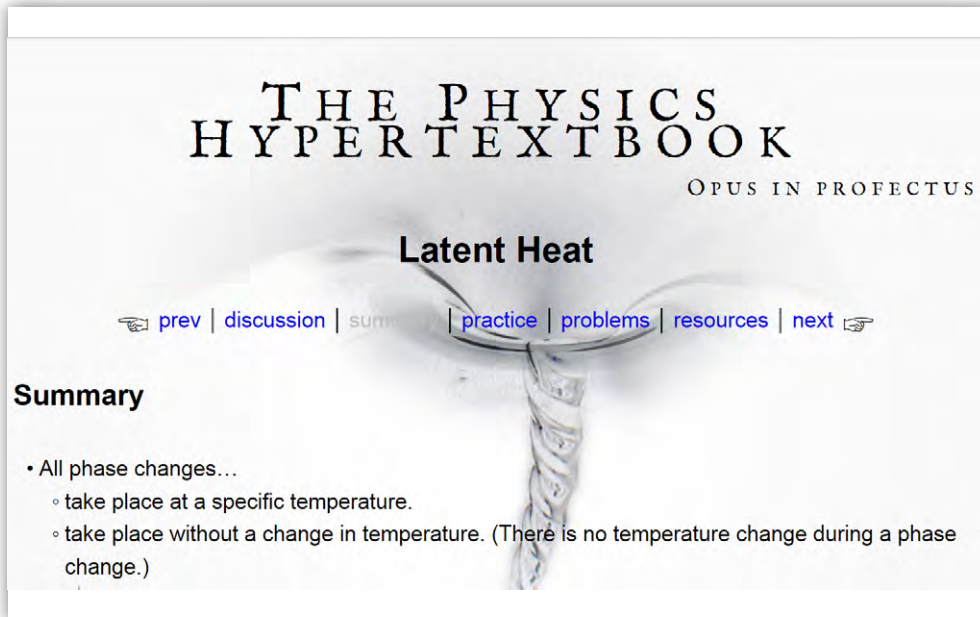
Cost:

Free

Format:

Web page

Latent Heat



**THE PHYSICS
HYPERTEXTBOOK**
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Latent Heat

[prev](#) | [discussion](#) | [summary](#) | [practice](#) | [problems](#) | [resources](#) | [next](#)

Summary

- All phase changes...
 - take place at a specific temperature.
 - take place without a change in temperature. (There is no temperature change during a phase change.)

<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

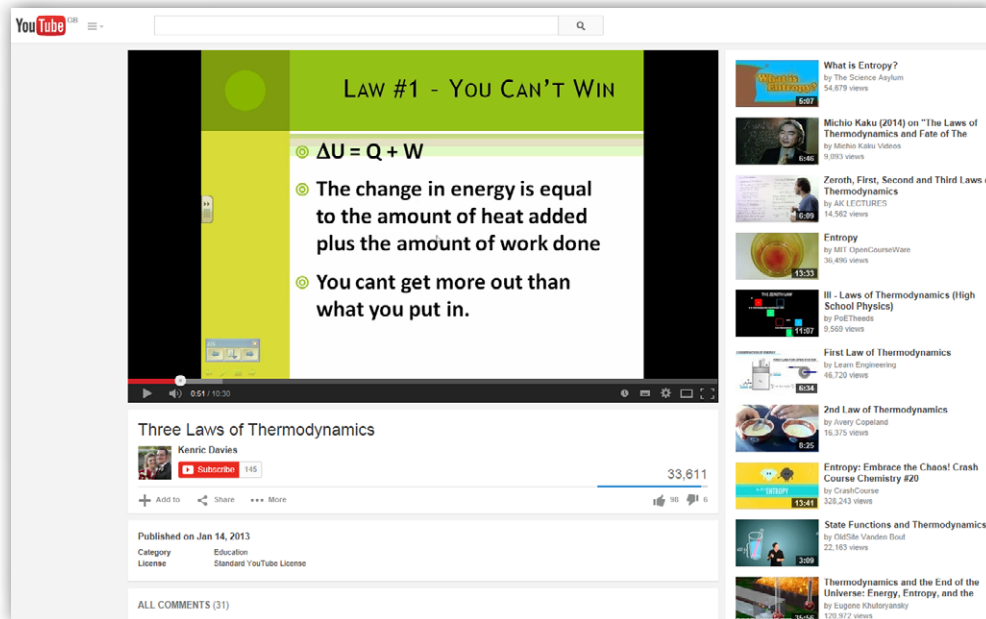
Cost:

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



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