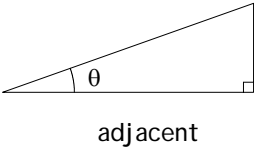
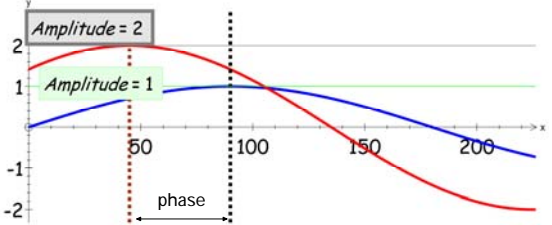
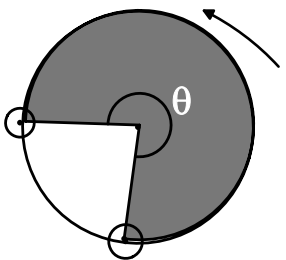
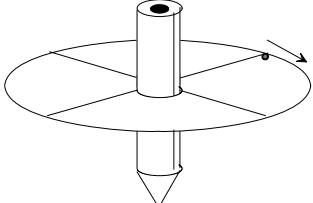
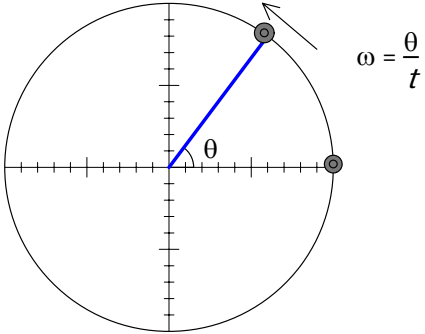
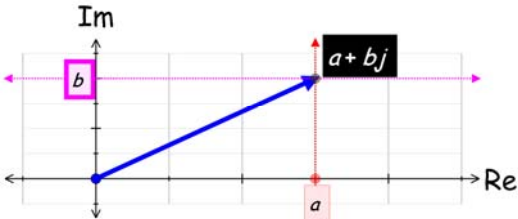
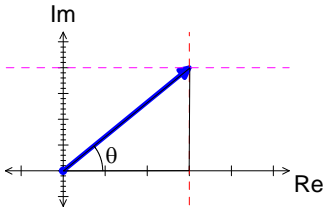
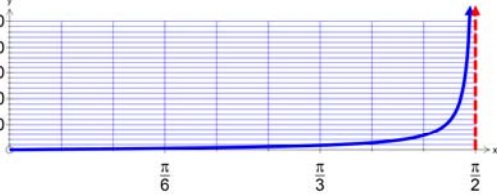
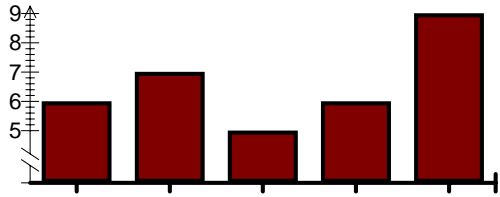
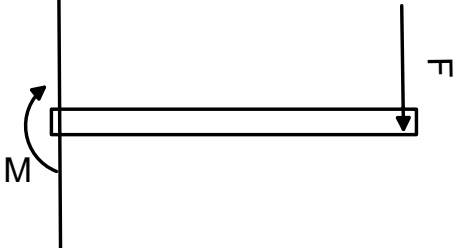



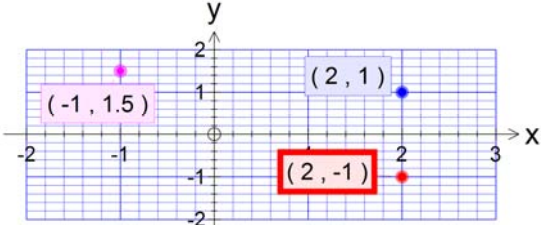
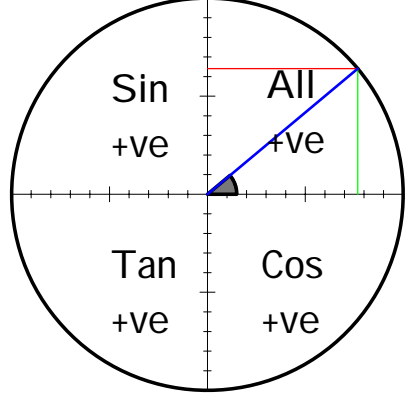
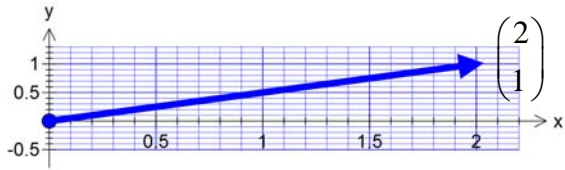
Glossary A to N

Term	Definition	Page References	Notes
acceleration	Rate of change of velocity. Symbol a . SI unit is m/s^2 .	56, 70, 106, 303, 349-354, 499-502	Acceleration due gravity is $9.81m/s^2$.
adjacent	Side of a triangle next to the angle.	172-178	
ampere	SI unit of electrical current. Symbol A.	33	
amplitude-phase form	Used to convert $a \cos(\theta) + b \sin(\theta)$ into $R \cos(\theta - \beta)$ where R is the amplitude and β is the phase of the waveform.	225, 229	
angular acceleration	Rate of change of angular velocity . Symbol α . SI unit is radians per second squared, rad/s^2 .	352-4	
angular displacement	The angle a rotating body sweeps. Symbol θ . SI unit is radians.	352-4	
angular motion	The motion of an object about a fixed point or an axis.	352-3	

angular velocity	The amount of rotation a spinning object does per unit time. Symbol is ω and SI unit is radians per second – rad/s	204-6, 211, 352-4, 552	 <p>$\omega = \frac{\theta}{t}$</p>
Argand diagram	A diagram which represents <u>complex numbers</u> in the plane.	526-30, 540, 543-44	
argument of a complex number	The angle which gives the direction of the <u>complex number</u> .	537	 <p>θ is the argument of the complex number</p>
asymptote	An asymptote is a line that approaches a given curve.	122	 <p>The line $x = \frac{\pi}{2}$ is an asymptote to the curve.</p>
atto	1 atto is 10^{-18} .	33	

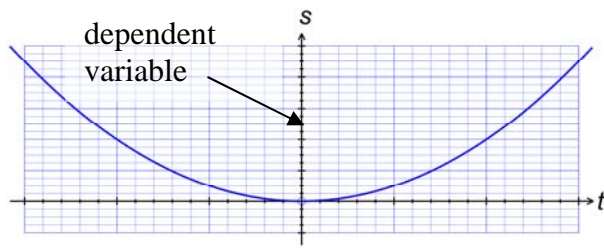
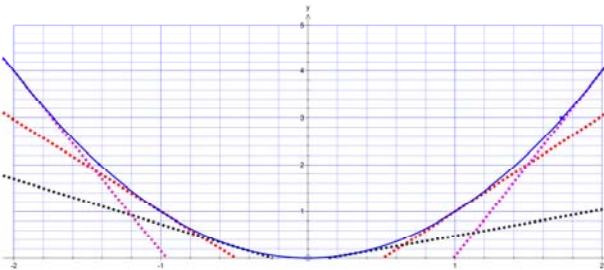
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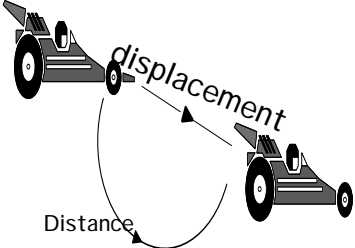
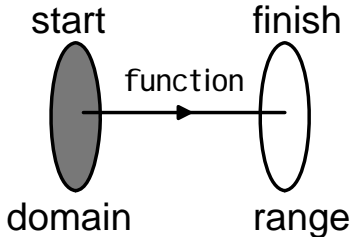
bar chart	A graphical representation of data by plotting bars.	812-814	
base of logarithm	If $b^x = a$ then $x = \log_b(a)$ where b is the base of the logarithm.	250-2	$\log_b(a)$ base of log
bending moment	The <u>moment</u> resulting from a force which causes bending of a beam. SI unit is Nm.	88	
boundary value problems	A differential equation with conditions given at different points.	742-3	Consider a beam of length L . The boundary conditions could be the deflections at the points $x = 0$ and $x = L$.

calculus	The study of rates of change.	272-276	Many physical systems involve rates of change which can be described through calculus.
Cantor set	By taking the interval $[0, 1]$ and removing the middle third each time results in the Cantor set.	379	
capacitor	An electronic device used for storing electrical charge.	689	Almost all electronic gadgets contain capacitors such as TV, mobile phones, computers and cd players.
Cartesian coordinate system	x - y plane representing the Cartesian coordinate system named after the French mathematician (philosopher) Rene Descartes.	102, 145, 181	
CAST	Mnemonic which gives the quadrant with the positive trigonometric ratio.	189-90	
coefficient	The number in front of the variable or multiplied by the variable.	103, 113	$7x + 1 = 0$ <p style="text-align: center;">7 is the coefficient of x</p>
column vector	A n by 1 <u>matrix</u> $\begin{pmatrix} v_1 \\ \vdots \\ v_n \end{pmatrix}$	583, 599, 615, 617	
common logarithm	<u>Logarithm</u> to the base 10. Symbol is log.	248-9	Inverse of 10^x .

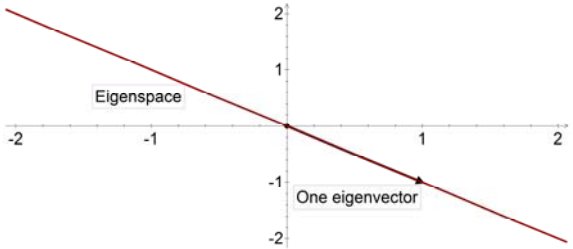
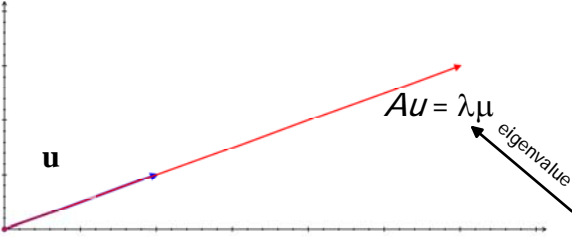
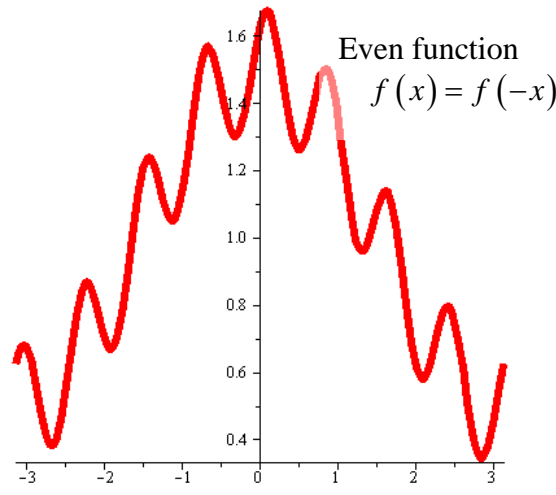
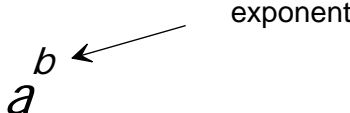
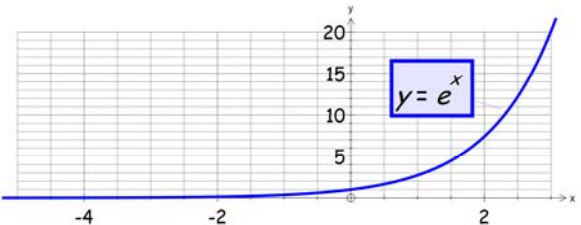
common ratio	Ratio of consecutive terms in a <u>geometric series</u> .	378	For example the common ratio of: $\frac{9}{10} + \frac{9}{100} + \frac{9}{1000} + \dots$ is 1/10.
complex conjugate	Reflecting the complex number $x + jy$ in the horizontal axis gives the complex conjugate $x - jy$. (The imaginary part changes sign.)	520-2, 524, 536	
complex number	A number made up by a real part and an imaginary part, $a + b\sqrt{-1}$.	517	For example $2 + 3\sqrt{-1} = 2 + 3j$ is a complex number.
composite function	Combining two or more functions. Normal notation is $g \circ f$.	153-5	
constant of integration	When <u>differentiating</u> a constant we get zero so integrating a function must have a constant and this is called the constant of <u>integration</u> .	400	The C in the following is the constant of integration.
cosecant	Is equal to $\frac{\text{hypotenuse}}{\text{opposite}}$ in a right-angled triangle. Normally denoted by cosec.	178-179, 263	
cotangent	Is equal to $\frac{\text{adjacent}}{\text{opposite}}$ in a right-angled triangle. Normally denoted by cot.	178-179, 263	

D

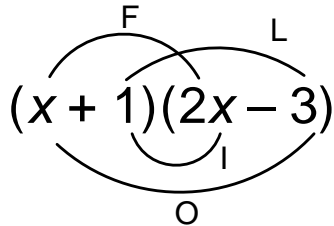
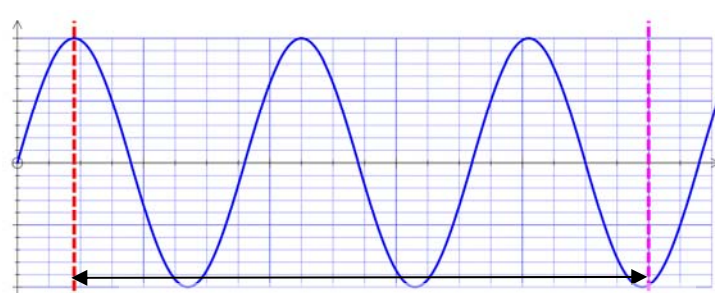
decibel (dB)	Used to measure sound in electronic or communication systems.	249	Examples are: Normal conversation is about 65 decibel. Hair dryer is approximately 90 decibel. Chainsaw is 100 to 110 decibel.
Degree of polynomial	The highest power of the variable in the <u>polynomial</u> .	444	The degree of the following polynomial is 7: $2x^7 + 6x^3 + 1$ An arrow points from the word "degree" to the exponent 7.
denominator	Bottom expression or number in a fraction.	16	$\frac{n}{d}$ An arrow points from the word "denominator" to the letter d.
dependent variable	A variable which depends on another variable.	102, 137	For example the displacement s of an object depends on time t : 
derivative - differentiation	Rate of change or gradient.	272- 80	Notice how the gradient changes as you move along the curve. 
diagonal matrix	An n by n matrix where all entries to both sides of the <u>leading diagonal</u> are zero.	625	An example is $\begin{pmatrix} 1 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 3 \end{pmatrix}.$
diagonalization	Converting a given matrix into a diagonal matrix.	624- 631	Diagonalization is used to find powers of matrices because it significantly reduces the amount of work required to evaluate this.

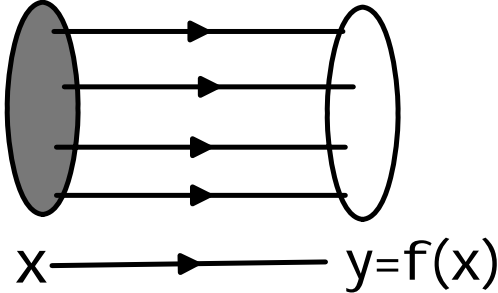
differential equation	An equation which contains a derivative.	673	An example of a differential equation is: $\frac{d^2 y}{dx^2} + 5 \frac{dy}{dx} + 6y = \cos(x)$
dimensional homogeneity	The dimensions of an equation which describes a physical system must be the same on both sides of the equation.	71	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: auto;"> Left Hand Dimensions = Right Hand Dimensions </div>
displacement	The shortest distance from start to finish.	106-8	
domain	The set where the function is defined or starts.	137	

E

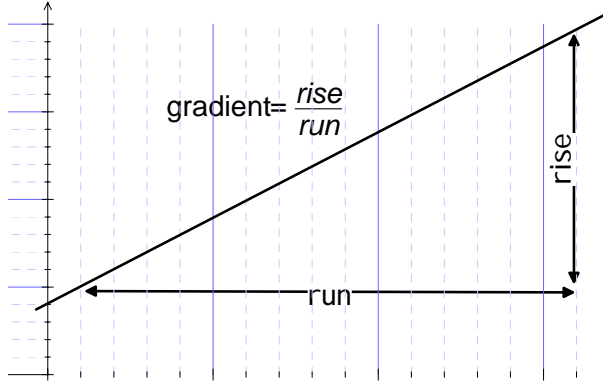
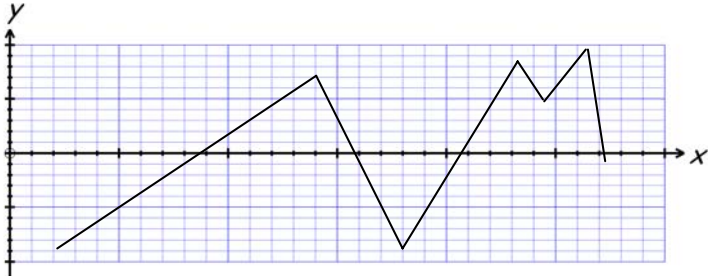
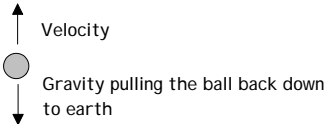
eigenspace	The set of all the <u>eigenvectors</u> and the zero vector. Normally denoted by E_λ .	622-623	
eigenvalue	A <u>scalar</u> quantity λ that scales the corresponding eigenvector.	613, 615	
eigenvector	A <u>vector</u> belonging to an <u>eigenvalue</u> .	615	\mathbf{u} is an eigenvector belonging to an eigenvalue λ such that $\mathbf{A}\mathbf{u} = \lambda\mathbf{u}$.
even function	A <u>function</u> which is <u>symmetrical</u> about the vertical axis.	111, 169	
exa (E)	Prefix in the metric system which represents 10^{18} .	33	1 000 000 000 000 000 000
exponent	The power or index of an expression.	32	
exponent function	The <u>function</u> e^x where $e = 2.71828\dots$	241	

F

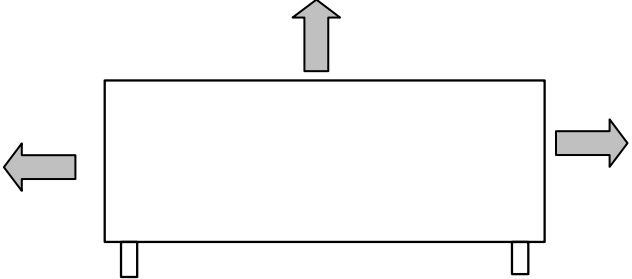
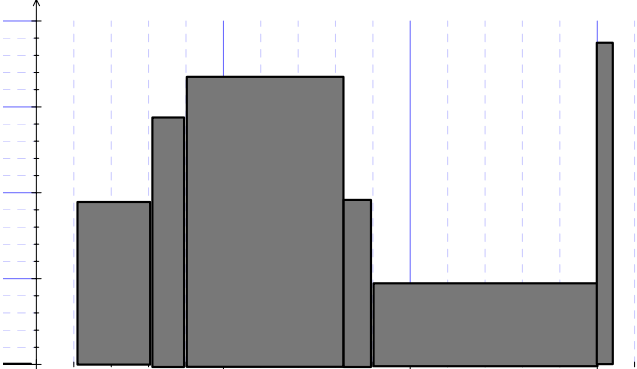
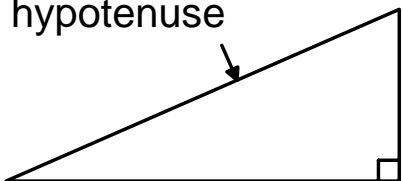
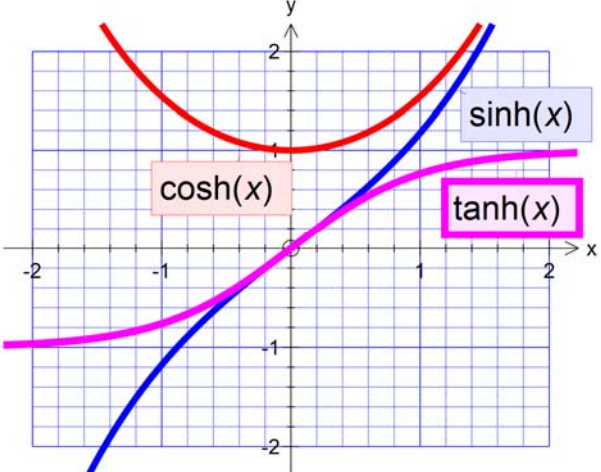
factors	The numbers or expressions which go exactly into another number or expression.	13-15, 78-79, 81-85,	For example $10 = 1 \times 10 = 2 \times 5$ We say 1, 2, 5 and 10 are factors of 10. In algebra $a^2 - b^2 = (a - b)(a + b)$ $a - b$ and $a + b$ are factors of $a^2 - b^2$.
farad (F)	SI unit of capacitance.	33, 63	In electronic gadgets the <u>capacitor</u> will have a value given in farad and is likely to be a small number such as <u>microfarad</u> , μF .
femto (f)	Prefix in the metric system which represents 10^{-15} .	33	0.000 000 000 000 001
FOIL	Mnemonic for First, Outside, Inside and Last.	75-76, 81	Used for expanding algebraic expressions with two brackets:  $(x + 1)(2x - 3)$
fraction	<u>Ratio</u> of two numbers.	16-18	Examples are: $\frac{1}{2}$ and $\frac{22}{7}$
frequency (statistics)	The number of times a particular event occurs.	807	If 10 students get 70% in a particular examination then we say 70% has a frequency of 10.
frequency (physics)	The number of cycles of a waveform per unit of time. SI unit is hertz (Hz).	206	 The number of cycles in one second = frequency

Froude number	Gives the influence of gravity on a fluid motion. It has no dimensions.	73	<p>The formula for the Froude number, Fr, is given by</p> $Fr = \frac{v}{\sqrt{gL}}$ <p>For a ship, v is velocity of the ship, g is acceleration due to gravity and L is the length of the ship at water level.</p>
function	Relationship between two quantities x and y . For each x , the function will assign only one value of y which is normally denoted by $f(x)$.	137	 <p>For a function you must have only one destination or one arrival point.</p>

G

geometric series	<u>Series</u> with a <u>common ratio</u> between any two consecutive terms.	378-383	<p>For example the following is a geometric series:</p> $0.999\dots = 0.9 + 0.09 + 0.009 + \dots$ $= \frac{9}{10} + \frac{9}{100} + \frac{9}{1000} + \dots$ <p>Common ratio is $\frac{1}{10}$.</p>
giga (G)	Prefix in the metric system which represents 10^9 .	33	<p>1 000 000 000</p>
gradient	The <u>ratio</u> of rise over run.	102-103	
graph	A diagram that represents the relationship between two or more <u>variables</u> .	101-105	<p>Stock market data is represented by a graph where the x coordinate is time and the y coordinate is price:</p> 
gravity	A force that acts towards the centre of the earth.	313, 658, 696, 787	<p>Consider a ball thrown vertically upwards:</p> 

H

<p>heat transfer</p>	<p>It is the transportation of heat from an object with high temperature to an object with a lower temperature.</p>	<p>46, 699-700</p>	<p>Consider a hot radiator in a room. The heat will flow from the radiator to the surrounding area of the room.</p> 
<p>henry (H)</p>	<p><u>SI</u> unit of inductance.</p>	<p>33</p>	<p>Common values of inductance are mH which is 10^{-3} H and μ H which is 10^{-6} H.</p>
<p>hertz (Hz)</p>	<p><u>SI</u> unit of frequency.</p>	<p>34</p>	<p>One hertz is one cycle per second.</p>
<p>histogram</p>	<p>Graphical representation of data which looks like a <u>bar chart</u> but the frequency is given by the area not the height.</p>	<p>810-812</p>	
<p>hypotenuse</p>	<p>The longest side of a right angled triangle.</p>	<p>172</p>	
<p>hyperbolic functions</p>	<p>Analogous to the trigonometric functions.</p>	<p>260</p>	

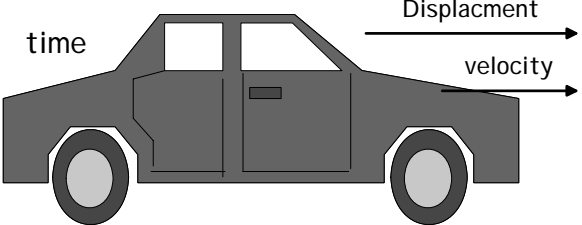
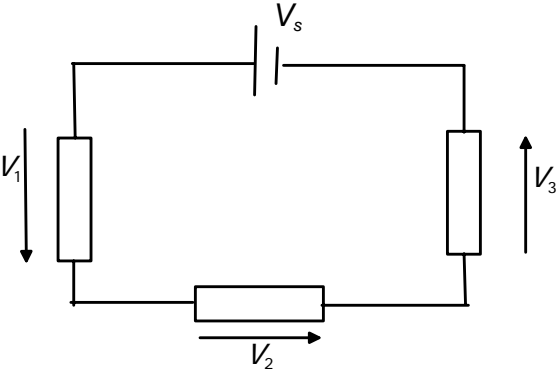
I

independent variable	A variable which does not depend on another variable. Normally the independent variable is denoted by x .	102, 137	
inductor	An electronic component which stores energy.	435, 689	An inductor is a coil of wire which resembles a doughnut.
integrand	The function being integrated.	400	$\int [\text{integrand}] d(\text{variable})$
integration	Inverse of <u>differentiation</u> .	400	
inverse function	The opposite or reverse of a given function.	141-144	<p>If $f(x)$ is the given function then the inverse is denoted by $f^{-1}(x)$:</p>

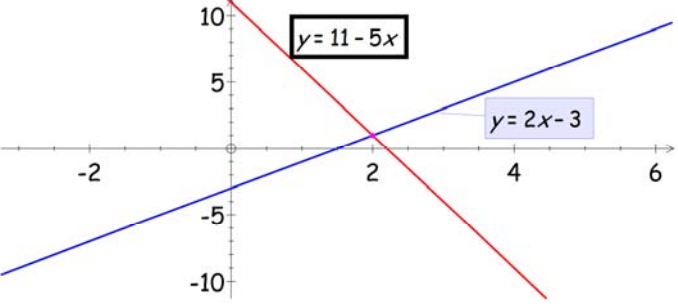
J

joule (J)	<u>SI</u> unit of <u>work</u> or energy.	34	One joule is the work done in applying a force of 1 Newton in moving an object by 1 metre.
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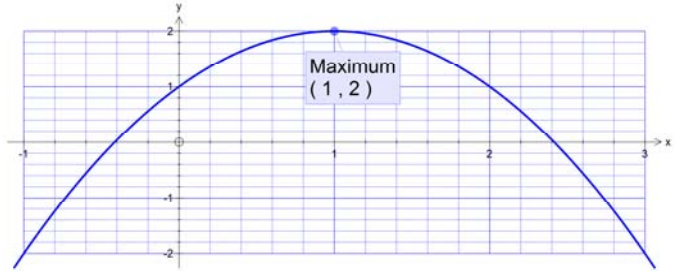

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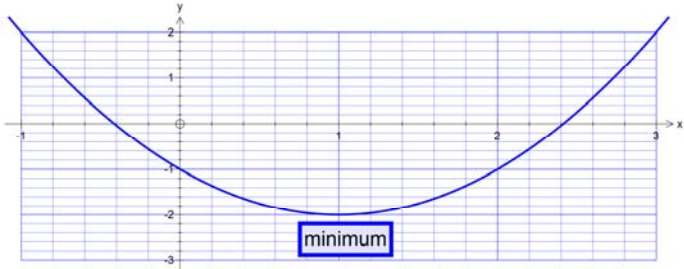
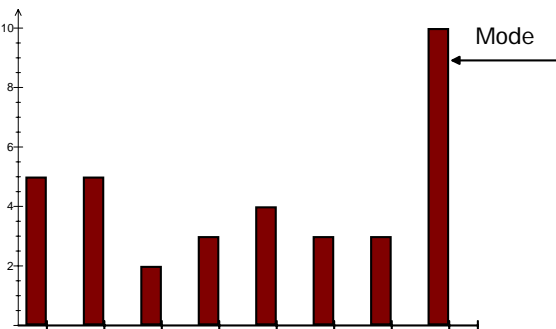
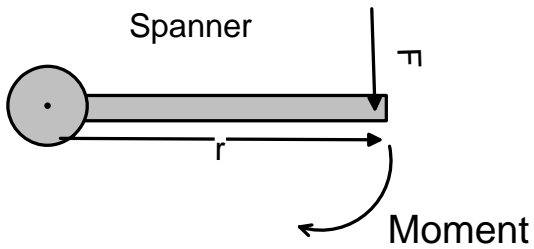
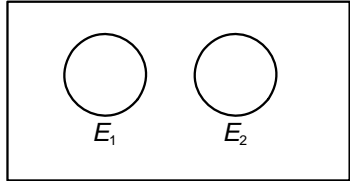
Kelvin (K)	SI unit of measuring temperature.	34	Zero Kelvin is called absolute zero. 0° C is equivalent to 273.16 K. 1 K has the same size as 1° Celsius.
kilo (k)	Prefix in the metric system which represents 1000.	33	For example 1km is 1000m.
kilogram (kg)	The SI measurement of mass.	33	Kilogram (kg) is 1000 grams. (This is equivalent to the mass of a packet of sugar.)
kinematics	Part of mechanics which deals with motion of body.	349-52	 <p>The diagram shows a side profile of a car. Two horizontal arrows point to the right from the front of the car. The top arrow is labeled 'Displacement' and the bottom arrow is labeled 'velocity'. To the left of the car, the word 'time' is written vertically.</p>
Kirchhoff's voltage law	In a closed loop of a electrical circuit the applied voltage is equal to the voltage drops in the loop.	689	<p>For example in the following loop, Kirchhoff's voltage law states that the supply voltage V_s is equal to $V_1 + V_2 + V_3$.</p>  <p>The diagram shows a rectangular circuit loop. At the top is a battery labeled V_s. On the left vertical wire is a resistor with a downward-pointing arrow labeled V_1. On the bottom horizontal wire is a resistor with a rightward-pointing arrow labeled V_2. On the right vertical wire is a resistor with an upward-pointing arrow labeled V_3.</p>

L

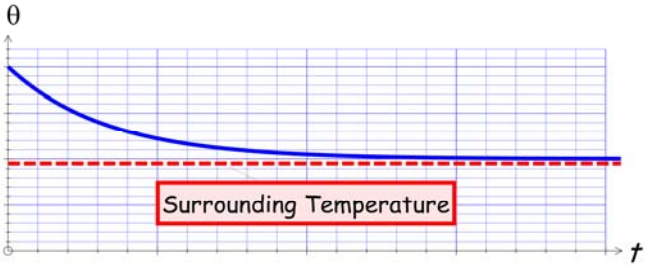
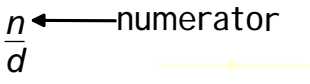
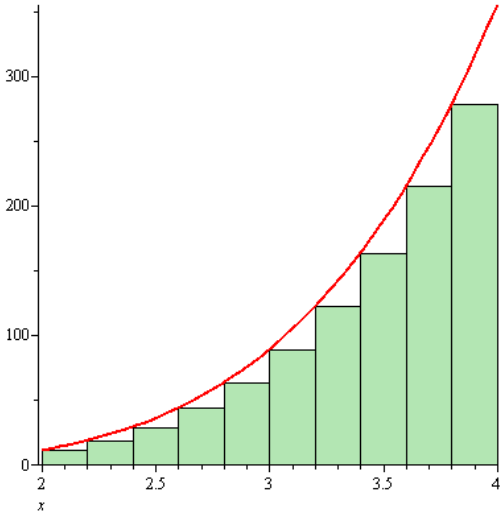
leading diagonal	The entries which go from top left to bottom right of a square matrix.	625	$\begin{pmatrix} 1 & * & * \\ * & 2 & * \\ * & * & 4 \end{pmatrix}$
linear equation	An equation where all the <u>variables</u> have an index of 1 or 0 only.	56, 90- 92, 581- 584, 598- 601, 607- 609	<p>Here are graphs of some examples of linear equations.</p> 
logarithmic function	Logarithm of a number is the power to which the <u>base</u> must be raised in order to produce that number.	246, 249	<p>For the following example the base is 10: $10^3 = 1000$ implies that $\log(1000) = 3$</p>
lowest common multiple (LCM)	The smallest number which is a multiple of two or more numbers.	12-15	<p>For example: Multiples of 3 are 3, 6, 9, 12, 15, 18, ... Multiples of 5 are 5, 10, 15, 20, 25, ... The LCM of 3 and 5 is 15.</p>

M

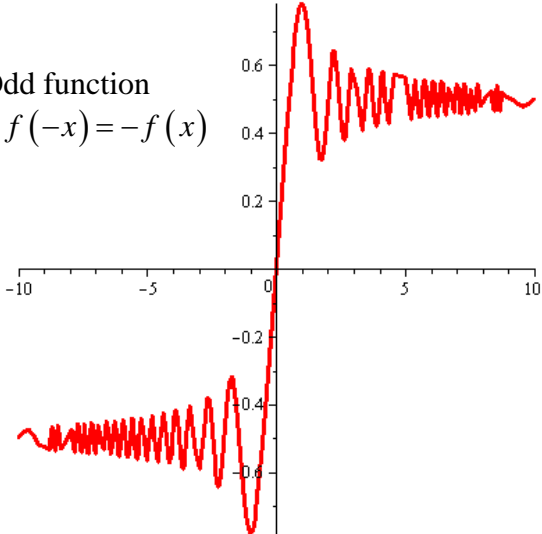
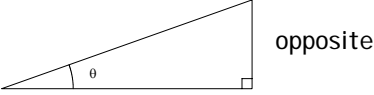
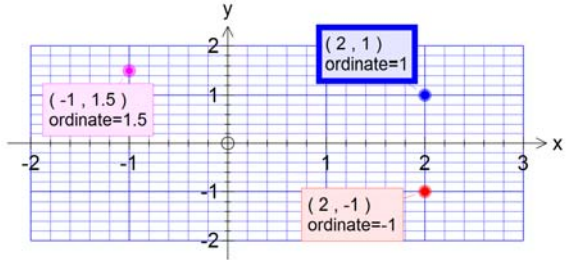
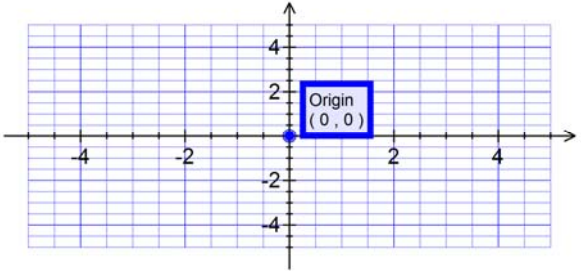
Mach number	The ratio of the speed of an object through a fluid and speed of sound.	73	An aircraft of Mach 2 means that it travels twice the speed of sound, which is 761mph. Hence Mach 2 = $2 \times 761 = 1522$ mph
Matrix or matrices (plural)	An array of numbers in a bracket.	561	An efficient and systematic way of solving a set of <u>linear equations</u> is to use matrices.
maximum	The greatest value a <u>function</u> takes over a given interval.	119, 329-330	
mean	Gives the average of the data by adding all the data and dividing by the number of data.	816-817	In the early nineties there was a TV programme called 2point4 children. This 2point4 was the mean number of children per family in Britain at that time. Mean of data $x_1, x_2, x_3, \dots, x_n$ is denoted by \bar{x} and is $\bar{x} = \frac{x_1 + x_2 + x_3 + \dots + x_n}{n}$
median	The middle value in an ordered list.	817-818	The median of the following data is 4: 1, 2, 3, 4 , 5, 6, 7
mega (M)	Prefix in the metric system which represents 10^6 .	33	Mega is one million, that is 1 000 000.
metre (m)	<u>SI</u> unit of length.	33	The metre has a length of 100cm. 
micro (μ)	Prefix in the metric system which represents 10^{-6} .	33	0.000 001

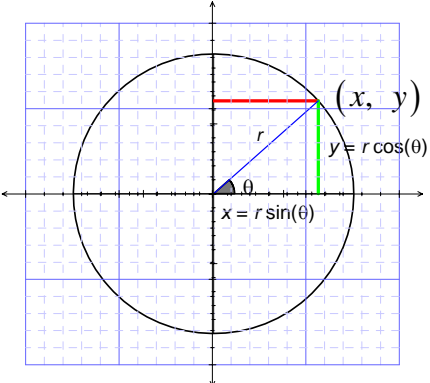
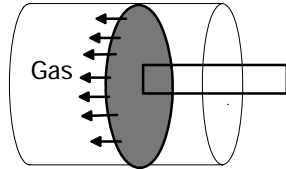
milli	Prefix in the metric system which represents 10^{-3} .	33	Milli often crops up in electronics where current normally has a value given in milliamps, mA.
minimum	The smallest value a function takes over a given interval.	119, 329-330	
micro (μ)	Prefix in the metric system which represents 10^{-6} .	33	0.000001
mode	The most popular value.	817	
moment	Measures the turning effect of a force that acts on an object which has a fixed point. SI unit is Nm and the symbol is M .	803	
mutually exclusive events	These events cannot occur at the same time.	834	 <p>There is no overlap between the two events E_1 and E_2.</p> <p>For example if we throw a die then we cannot get both a 3 and a 4.</p>

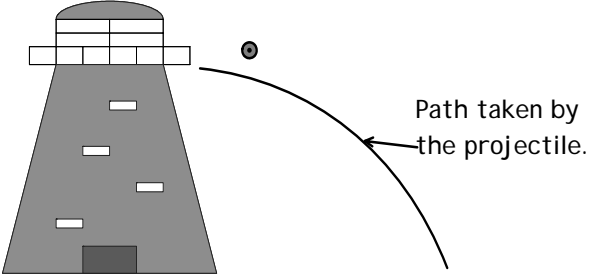
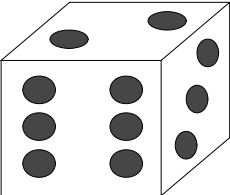
N

nano	Prefix in the metric system which represents 10^{-9} .	33	0.000 000 001
newton (N)	<u>SI</u> unit of force.	34, 70	If your mass is 70kg then your weight (which is a force) would be $70 \times 9.81 = 686.7\text{N}$ The weight of an apple is approximately 1N.
Newton's law of cooling	The rate of change of temperature of a body is proportional to the difference between the temperature of the body and the surrounding temperature.	699	Newton's law of cooling tells you how long it takes for a cup of coffee to reach room temperature. The graph below illustrates Newton's law of cooling with temperature given by θ and time t . 
numerator	Top expression or number in a fraction.	16	$\frac{n}{d}$ ← numerator 
numerical integration	The approximate evaluation of a definite integral by numerical methods.	473	The definite integral is approximated by considering the area: 

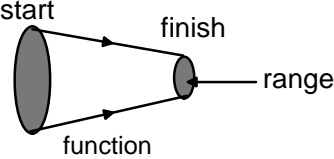
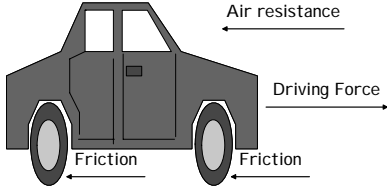
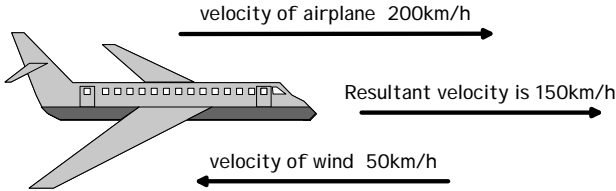
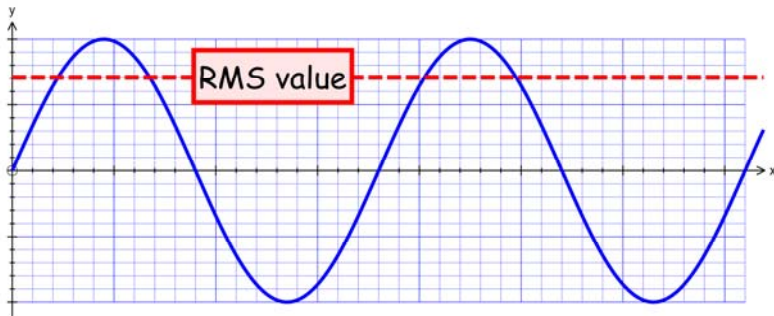
Glossary O to Z

<p>Odd function</p>	<p>A <u>function</u> with the property $f(-x) = -f(x)$.</p>	<p>111, 169</p>	<p>Odd function $f(-x) = -f(x)$</p> 
<p>ohm</p>	<p><u>SI</u> unit of electrical resistance. Symbol is Ω.</p>	<p>33</p>	<p>A resistor of $1\ \Omega$ means that if a voltage of 1V is applied to this resistor then the current through this resistor would be 1A.</p>
<p>Ohm's law</p>	<p>The voltage across a conductor is proportional to the current through it.</p>	<p>689</p>	<p>The formula for Ohm's law is $V = IR$ where V is voltage, I is current and R is resistance.</p>
<p>opposite</p>	<p>The side opposite the given angle in a triangle.</p>	<p>141- 142</p>	
<p>ordinate</p>	<p>The y value of a point in the <u>Cartesian coordinate system</u>.</p>	<p>475, 481</p>	
<p>origin</p>	<p>The point where the axes intersect. Normally denoted by O.</p>	<p>102</p>	

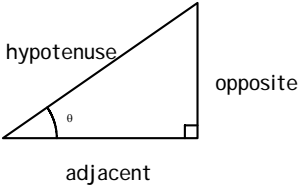
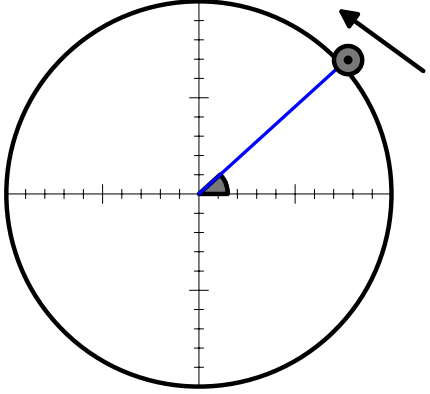
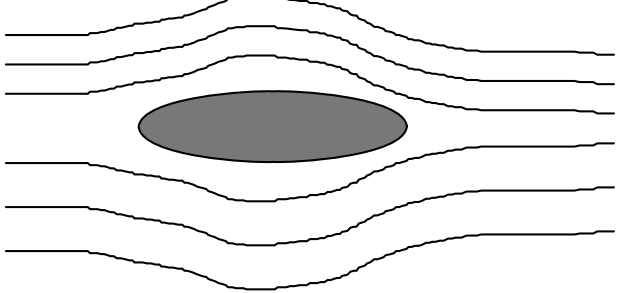

parameter	An independent variable, normally time t or angle θ , that gives the coordinates of a point.	308	<p>The coordinates of a point (x, y) rotating about the origin can be given by the angle θ as follows:</p> 
partial fractions	Splitting a single fraction into two or more fractions.	441-442	<p>Example is:</p> $\frac{5}{6} = \frac{1}{2} + \frac{1}{3}$ <p>We say $\frac{1}{2}$ and $\frac{1}{3}$ are partial fractions of $\frac{5}{6}$.</p> <p>Another example:</p> $\frac{5x+10}{(x+6)(x+1)} = \frac{4}{x+6} + \frac{1}{x+1}$ <p>Similarly $\frac{4}{x+6}$ and $\frac{1}{x+1}$ are partial fractions of $\frac{5x+10}{(x+6)(x+1)}$.</p>
pascal	<u>SI</u> unit of pressure.	34	
peta (P)	Prefix in the metric system which represents 10^{15} .	33	1 000 000 000 000 000
pico	Prefix in the metric system which represents 10^{-9} .	33	0.000 000 001
pressure	The force per unit area. SI unit is <u>pascal</u> (Pa).	241-2	<p>The pressure of a gas in a piston:</p> 

polynomial	An algebraic expression where the index of the variable must be a positive whole number or zero.	444	An example is $2x^{10} + 3x^9 + 4x^5 + 9x + 1$.
projectile	An object upon which the only force acting on it is <u>gravity</u> .	313	
prime	A whole number greater than 1 whose only divisors are 1 and itself.	13	The first few prime numbers are 2, 3, 5, 7, 11, 13, 17, 19, ...
probability	Measures how likely a particular event will occur.	828-830	For example the probability of getting a 2 on throwing a six sided die is $\frac{1}{6}$: 

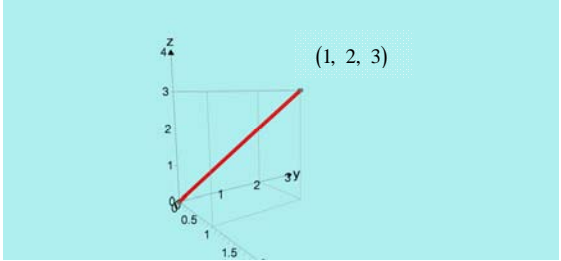
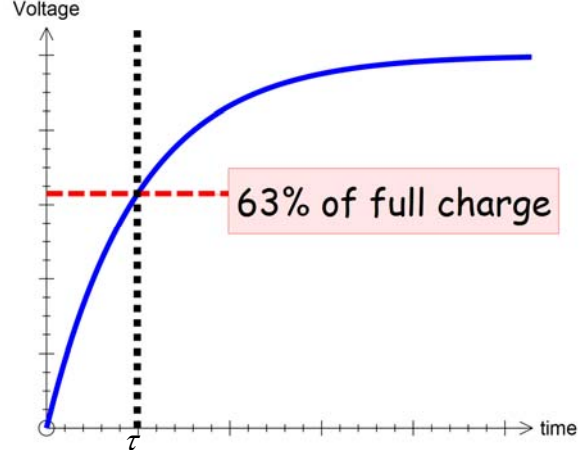
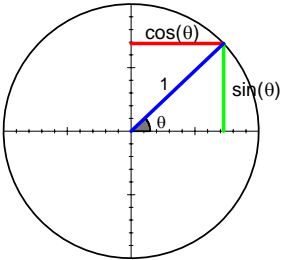
R

random variable	A variable associated by experiment and the value determined by chance.	845-846	For example, if X is the variable representing the total score on two dice then X is a random variable.
range	The set of all the output values of a given function.	137	<p>The set of arrival points is the range.</p> 
ratio	Relationship between two or more quantities.	48-50	Ratio is normally used to compare two or more quantities. For example the ratio of boys to girls in a classroom is 2 to 1, denoted 2:1, means there are twice as many boys as there are girls.
resultant force	The net force of adding all the forces acting on an object.	530-531	<p>The car can only travel if the resultant force is larger than the forces working against it.</p> 
resultant velocity	The net velocity of adding all the velocities acting on an object.	642-643	
root mean square (rms)	Taking the square root of the <u>mean</u> of the squares of a set of numbers or waveform.	492-493	 <p>The above rms value is the average of the modulus of the waveform.</p>

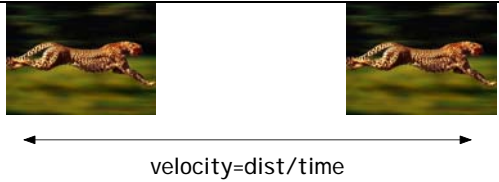
S

scalar	Only has magnitude.	562, 637	The distance between two points is a scalar.
secant	Is equal to $\frac{\text{hypotenuse}}{\text{adjacent}}$ Normally denoted by sec.	178, 263	
series	The sum of mathematical terms in some order.	358- 389	An example is $1 + 2 + 3 + 4 + 5 + 6 + \dots$
SI units	Units of measurement based on the metric system.	32	Some SI quantities are: Length measured in metre. Time in second. Mass in kilogram.
Simple harmonic motion (SHM)	A motion of an object which is periodic such as the oscillation of a spring or a bicycle wheel.	304	
streamlines	Path traced out by a particle which moves with the flow of a fluid.	104, 111, 679	
symmetry	The quality of being exactly the same.	168, 176, 781, 878 and 881	

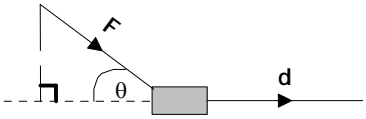
T

tera (T)	Prefix in the metric system which represents 10^{12} .	33	1 000 000 000 000
three dimensional co-ordinate system	Three axes at right angles to each other and every point is identified by three co-ordinates (x, y, z) .	774	
time constant	The time needed to charge a capacitor through a resistor to 63% of its full charge. Symbol is τ .	242-243	<p>τ is normally in milliseconds (ms).</p> 
tolerance limits	Variation from a standard specification.	35, 45, 785	Consider a 100Ω resistor with a tolerance limit of 10%. This means the resistor value lies between 90Ω to 110Ω .
transient term	A term that exists for a very short time at the start.	693	Generally when switching on an electronic gadget it takes time to settle. For example when switching on a loudspeaker the initial noise which might only last for a few milliseconds is called the transient and the mathematical expression associated with this is called the transient term.
trigonometric functions.	Sine, cosine and tangent. Sometimes called the circular functions.	175	

V

variable	A value that changes.	53,55	
vector	A quantity that has magnitude and direction.	637	Examples of vectors are velocity, acceleration, force, displacement and moment.
velocity	Rate of change of position of an object. Symbol v and SI unit is m/s.	57, 70-73, 84, 91	
volt (V)	<u>SI</u> unit of voltage.	33	

W

watt (W)	<u>SI</u> unit of power.	34	<p>1W is equal to 1 joule per second. Consider walking up some steps at a rate of 0.5m/s and your weight is $75 \times 10 = 750$ N. The rate of working up these steps is</p> $750 \times 0.5 = 375 \text{ W}$
work	The transfer of energy.	659	 <p>The work done in pushing the object by a distance d is the multiplication of the distance moved d and the magnitude of the applied force in the direction of motion.</p>