How to read the mathematical and scientific symbols

In this course I try to select and to provide a minimum of mathematical and scientific terms and their abbreviations In addition to the Common pronunciations (in British English) of the most mathematical and scientific symbols are given. The course aims at developing students' language skills in an English context of mathematics and science with emphasis on reading, and writing of mathematical and scientific symbols.

01-The mathematical symbols

+	plus	/'plʌs/
-	minus	/'maɪnəs/
±	plus or minus	/'plʌs ɔ: 'maɪnəs/
x	multiplied by	/'mʌltɪplaɪd baɪ/
/	over; divided by	/'əʊvə/ /dɪ'vaɪdəd/
÷	divided	/dɪ'vaɪdəd/
=	equals	/'ɪ:kwəlz/
≈	approximately, similar	/ə'prɒksɪmətlɪ/ /'sɪmɪlə tʊ/
≡	equivalent to; identical	/ɪk'wɪvələnt tʊ/ /aɪ'dentɪkl tʊ/
≠	not equal to	/'nɒt 'i:kwəl tʊ/
>	greater than	/'greɪtə ðən/
<	less than	/'les ðən/
≥	greater than or equal to	/'greɪtə ðən ər 'i:kwəl tʊ/
≤	less than or equal to	/'les ðən ər' i:kwəl tʊ/
≯	not greater than	/'nɒt 'greɪtə ðən/
≮	not less than	/'nɒt 'les ðən/
≫	much greater than	/'mʌʧ 'greɪtə ðən/
≪	much less than	/'mʌʧ 'les ðən/
⊥	perpendicular to	/pɜ:pən'dɪkjʊlə tʊ/
||	parallel to	/'pærəlel tʊ/
≢	not equivalent to, not identical to	/'nɒt ɪk'wɪvələnt tʊ/ /'nɒt aɪ'dentɪkl tʊ/
≠≠	not similar to	/'nɒt 'sɪmɪlə tʊ/
^{2}	squared	/'skweəd/
^{3}	cubed	/'kju:bd/
^{4}	to the fourth; to the power four	/tə ðə 'fɔ:θ/ /te ðə 'paʊə fɔ:/
^{n}	to the n; to the nth; to the power n	/tə ðɪ en; tə dɪ enθ; tə ðə paʊər en/
√	root; square root	/ru:t/ /skweə ru:t/
∛	cube root	/kju:b ru:t/
∜	fourth root	/fɔ:θ ru:t/
!	factorial	/fæk'tɔ:rɪəl/
%	percent	/pə'sent/
∞	infinity	/ɪn'fɪnətɪ/
∝	varies as; proportional to	/'vɛərɪz/ /prə'pɔ:ʃənəl/
˙	dot	/dɒt/
¨	double dot	/dʌbl dɒt/
:	is to, ratio of	/reɪʃɪəʊ/
f(x) fx	f; function	/ef/ /'fʌŋkʃən/
f'(x)	f dash; derivative	/dæʃ/ /dɪ'rɪvətɪv/
f''x	f double-dash; second derivative	/'dʌbl dæʃ/ /'sekənd dɪ'rɪvətɪv/
f'''(x)	f triple-dash; f treble-dash; third derivative	/'trɪpl dæʃ/ / trebl dæʃ/ /θɜ:d dɪ'rɪvətɪv/
$f^{(4)}$	f four; fourth derivative	/fɔ:θ dɪ'rɪvətɪv/
∂	partial derivative, delta	/pa:ʃəl dɪ'rɪvətɪv/ /deltə/

∫	integral	/'ɪntɪgrəl/
Σ	sum	/sʌm/
w.r.t.	with respect to	/wɪð 'rɪspekt/
log	log	/lɒg/
log_2x	log to the base 2 of x	/lɒg tə ðə beɪs tu: əv eks/
∴	therefore	/'ðɛəfɔ:/
∵	because	/bɪ'kɒz/
→	gives, leads to, approaches	/gɪvz/ /li:dz tʊ/ /əprəʊʧəz/
/	per	/pɜ:/
∈	belongs to; a member of; an element of	/bɪ'lɒŋz/ /'membə/ /'elɪmənt/
∉	does not belong to; is not a member of; is not an element of	/nɒt bɪ'lɒŋ/ /nɒt ə 'membə/ /nɒt ən 'elɪmənt/
⊂	contained in; a proper subset of	/kən'teɪnd ɪn/ /'prɒpə 'sʌbset/
⊆	contained in; subset	/'sʌbset/
∩	intersection	/'ɪntəsekʃən/
∪	union	/'ju:nɪən/
∀	for all	/fə rɔ:l/
cos x	cos x; cosine x	/kɒz/
sin x	sine x	/saɪn/
tan x	tangent x	/tan/
cosec x	cosec x	/'kəʊsek/
sinh x	shine x	/'ʃaɪn/
cosh x	cosh x	/'kɒʃ/
tanh x	than x	/θæn/
|x|	mod x; modulus x	/mɒd/ /'mɒdjʊləs/
°C	degrees Centigrade	/dɪ'gri:z 'sentɪgreɪd/
°F	degrees Fahrenheit	/dɪ'gri:z 'færənhaɪt/
°K	degrees Kelvin	/dɪ'gri:z 'kelvɪn/
0°K, –273.15 °C	absolute zero	/absəlu:t zi:rəʊ/
mm	millimetre	/'mɪlɪmi:tə/
cm	centimetre	/'sentɪmi:tə/
cc, cm^3	cubic centimetre, centimetre cubed	/'kju:bɪk 'sentɪmi:tə/ /'sentɪmi:tə 'kju:bd/
m	metre	/'mi:tə/
km	kilometre	/kɪ'lɒmɪtə/
mg	milligram	/'mɪlɪgræm/
g	gram	/græm/
kg	kilogram	/'kɪləgræm/
AC	A.C.	/eɪ si:/
DC	D.C.	/di: si:/

Examples

$x + 1$	x plus one
$x - 1$	x minus one
$x \pm 1$	x plus or minus one
xy	x y; x times y; x multiplied by y
$(x - y)(x + y)$	x minus y, x plus y
x/y	x over y; x divided by y;
$x \div y$	x divided by y
$x = 5$	x equals 5; x is equal to 5
$x \approx y$	x is approximately equal to y
$x \equiv y$	x is equivalent to y; x is identical with y
$x \neq y$	x is not equal to y
$x > y$	x is greater than y
$x < y$	x is less than y
$x \geq y$	x is greater than or equal to y
$x \leq y$	x is less than or equal to y
$0 < x < 1$	zero is less than x is less than 1; x is greater than zero and less than 1
$0 \leq x \leq 1$	zero is less than or equal to x is less than or equal to 1; x is greater than or equal to zero and less than or equal to 1
x^2	x squared
x^3	x cubed
x^4	x to the fourth; x to the power four
x^n	x to the n; x to the nth; x to the power n
x^{-n}	x to the minus n; x to the power of minus n
$\sqrt{}$	root x; square root x; the square root of x
$\sqrt[3]{}$	the cube root of x
$\sqrt[4]{}$	the fourth root of x
$\sqrt[n]{}$	the nth root of x
$(x + y)^2$	x plus y all squared
$(x/y)^2$	x over y all squared
$n!$	n factorial; factorial n
$x\%$	x percent
∞	infinity
$x \propto y$	x varies as y; x is (directly) proportional to y
$x \propto 1/y$	x varies as one over y; x is indirectly proportional to y
$\dot{x}$	x dot
$\ddot{x}$	x double dot
$f(x)$ fx	f of x; the function of x
$f'(x)$	f dash x; the (first) derivative of with respect to x
$f''x$	f double-dash x; the second derivative of f with respect to x
$f'''(x)$	f triple-dash x; f treble-dash x; the third derivative of f with respect to x
$f^{(4)}$	f four x; the fourth derivative of f with respect to x
∂v	the partial derivative of v
$\frac{\partial v}{\partial \theta}$	delta v by delta theta, the partial derivative of v with respect to θ

$x \in A$	x belongs to A; x is a member of A; x is an element of A
$x \notin A$	x does not belong to A; x is not a member of A; x is not an element of A
$A \subset B$	A is contained in B; A is a proper subset of B
$A \subseteq B$	A is contained in B; A is a subset of B
$A \cap B$	A intersection B
$A \cup B$	A union B
cos x	cos x; cosine x
sin x	sine x
tan x	tangent x, tan x
cosec x	cosec x
sinh x	shine x
cosh x	cosh x
tanh x	than x
$\|x\|$	mod x; modulus x
18 °C	eighteen degrees Centigrade
70 °F	seventy degrees Fahrenheit
$\frac{\partial^2 v}{\partial \theta^2}$	delta two v by delta theta squared; the second partial derivative of v with respect to θ
dv	the derivative of v
$\frac{dv}{d\theta}$	d v by d theta, the derivative of v with respect to theta
$\frac{d^2 v}{d\theta^2}$	d 2 v by d theta squared, the second derivative of v with respect to theta,
$\int$	integral
$\int_0^\infty$	integral from zero to infinity
Σ	sum
$\sum_{i=1}^{n}$	the sum from i equals 1 to n
w.r.t.	with respect to
$\log_e y$	log to the base e of y; log y to the base e; natural log (of) y
$\therefore$	therefore
$\because$	because
$\rightarrow$	gives, approaches
$\Delta x \rightarrow 0$	delta x approaches zero
$\lim_{\Delta x \rightarrow 0}$	the limit as delta x approaches zero, the limit as delta x tends to zero
$\mathrm{Lt}_{\Delta x \rightarrow 0}$	the limit as delta x approaches zero, the limit as delta x tends to zero
m/sec	metres per second

Fractions

½	a half	/ə 'hɑ:f/
¼	a quarter	/ə 'kwɔ:tə/
¾	three quarters	/θri: 'kwɔ:təz/
⅓	a third	/ə 'θɜ:d/
⅔	two thirds	/tu: 'θɜ:dz/
⅕	a fifth	/ə 'fɪfθ/
⅖	two fifths	/tu: 'fɪfθs/
⅗	three fifths	/θri: 'fɪfθs/
⅘	four fifths	/fɔ: 'fɪfθs/
⅙	a sixth	/ə 'sɪksθ/
⅚	five sixths	/faɪv 'sɪksθs/
⅛	an eighth	/ən 'eɪtθ/
⅜	three eighths	/θri: 'eɪtθs/
⅝	five eighths	/faɪv 'eɪtθs/
⅞	seven eighths	/sevən 'eɪtθs/

Decimal Fractions

0.1	nought point one	/nɔ:t pɔɪnt wʌn/
0.01	nought point oh one	/nɔ:t pɔɪnt əʊ wʌn/
0.0001	nought point oh oh oh one	/ten pɔɪnt əʊ əʊ əʊ wʌn/
1.1	one point one	/wʌn pɔɪnt wʌn/
1.2	one point two	/wʌn pɔɪnt tu:/
1.23	one point two three	/wʌn pɔɪnt tu: θri:/
1.0123	one point oh one two three	/wʌn pɔɪnt əʊ wʌn tu: θri:/
10.01	ten point oh one	/ten pɔɪnt əʊ wʌn/
21.57	twenty-one point five seven	/'twentɪ wʌn pɔɪnt faɪv 'sevən/
2.6666666666....	two point six recurring	/tu: pɔɪnt sɪks rɪ'kɜ:rɪŋ/
2.612361236123...	two point six one two three recurring	/tu: pɔɪnt sɪks wʌn tu: θri: rɪ'kɜ:rɪŋ/
2.5 million	two point five million	/tu: pɔɪnt faɪv 'mɪljən/

Greek alphabet

A	α	alpha	B	β	beta	Γ	γ	gamma	Δ	δ	delta	E	ϵ, ε	epsilon
Z	ζ	zeta	H	η	eta	Θ	θ, ϑ	theta	I	ι	iota	K	κ	kappa
Λ	λ	lambda	M	μ	mu	N	ν	nu	Ξ	ξ	xi	O	o	omicron
Π	π, ϖ	pi	P	ρ, ϱ	rho	Σ	σ, ς	sigma	T	τ	tau	Υ	υ	upsilon
Φ	ϕ, φ	phi	X	χ	chi	Ψ	ψ	psi	Ω	ω	omega			

Important sets

$\emptyset$	empty set		
$\mathbb{N}$	natural numbers	$\{0, 1, 2, \ldots\}$	
$\mathbb{N}^+$	positive integer numbers	$\{1, 2, \ldots\}$	
$\mathbb{Z}$	integer numbers	$\{\ldots, -2, -1, 0, 1, 2, \ldots\}$	
$\mathbb{Q}$	rational numbers	$\{m/n : m \in \mathbb{Z}, n \in \mathbb{N}^+\}$	
$\mathbb{R}$	real numbers	$(-\infty, +\infty)$	
$\mathbb{R}^+$	positive real numbers	$(0, +\infty)$	
$\mathbb{C}$	complex numbers	$\{x + iy : x, y \in \mathbb{R}\}$	(i is the imaginary unit, $i^2 = -1$)

02- <u>The scientific symbols</u>

Number	Derived from number words in		
	Greek	Latin	Old English
¼	-	-	-
½	Hemi-	semi-/demi-	
1	Mono-	uni-	
1½		sesqui-	
2	di-	Duo-/bi-	twi-

3	tri-	tre-/ter-	
4	tetra-/tetr-	quadri-/quadr- /quart	
5	Penta-/pent-	quinque- /quinqu-/ quint	
6	hexa-/hex-	sexa-/sex-/se	
7	Hepta-/hept-	Sept	
8	Octa-/octo-/oct-		
9	ennea-	nona-/non- /novem	
10	deka-/deca-	deci-/dec(a)-	
11	hendeca-	undec-/unde-	
12	Dodeca-	duodec-/duode-	
13	triskaideca, trideca	tredec, tridec	
14	Tetrakaideca- /tetradeca	Quatuordec	

15	pent(a)deca-/ pendeca-	quinde(c)	
16	hexadeca-	Sede(c)	
17	Heptadeca	septende(c)	
18	Ocatadeca	decennoct	
19	Enneadeca-	decennov	
20	Icos(a)-	Vige-/vice-	
100	hecto-/hect-	Centi-/cente-	
1000	chilia-/kilo-	milli-/mille-	
10000	myria-		

Symbol	**Name**	**Pronunciation**
Ag	Silver	/'sɪlvə/
Al	Aluminium	/æljʊ'mɪnɪəm/
Au	Gold	/'gəʊld/
Br	Bromine	/ˈbrəʊmiːn/
C	Carbon	/ˈkɑːbən/
Ca	Calcium	/ˈkælsɪəm/
Cl	Chlorine	/ˈklɔːriːn/
Cu	Copper	/ˈkɒpə/
Db	Dubnium	/ˈdʌbnɪəm/
F	Fluorine	/ˈflʊəriːn/
Fe	Iron	/ˈaɪən/
S	Sulphur	/ˈsʌlfə/
Si	Silicon	/ˈsɪlɪkən/
Ti	Titanium	/tɪˈteɪnɪəm/
U	Uranium	/jʊˈreɪnɪəm/
Uub	Ununbium	/juːˈnʌnbɪəm/
Xe	Xenon	/ˈzenɒn/
Y	Yttrium	/ˈɪtrɪəm/
Yb	Ytterbium	/ɪˈtɜːbɪəm/
V	Vanadium	/vəˈneɪdɪəm/

Ga	Gallium	/ˈgælɪəm/
H	Hydrogen	/ˈhaɪdrədʒən/
He	Helium	/ˈhiːlɪəm/
Hf	Hafnium	/ˈhæfnɪəm/
Hg	Mercury	/ˈmɜːkjʊrɪ/
K	Potassium	/pəˈtæsɪəm/
Kr	Krypton	/ˈkrɪptən/
Md	Mendelevium	/mendəˈlɪvɪəm/
Mg	Magnesium	/mægˈniːzɪəm/
Mn	Manganese	/ˈmæŋgəniːz/
N	Nitrogen	/ˈnaɪtrədʒən/
Na	Sodium	/ˈsəʊdɪəm/
Ni	Nickel	/ˈnɪkəl/
O	Oxygen	/ˈɒksɪdʒən/
P	Phosphorus	/ˈfɒsfərəs/
Pb	Lead	/ˈled/
Pt	Platinum	/ˈplætɪnəm/
Pu	Plutonium	/pluːˈtəʊnɪəm/
Ra	Radium	/ˈreɪdɪəm/
Uuh	Ununhexium	/ˌjuːnənˈheksɪəm/
Zn	Zinc	/ˈzɪŋk/

Formulae

CO_2	Carbon dioxide
CO	Carbon monoxide
NO_2	Nitrogen dioxide
N_2O	Dinitrogen oxide
NO	Nitrogen oxide
N_2O_4	Dinitrogen tetroxide
SO_2	Sulphur dioxide
SO_3	Sulphur trioxide
H_2SO_4	Suphuric acid
HCl	Hydrochloric acid
HNO_3	Nitric acid
PCl_5	Phosphorus pentachloride

The following table lists the names alkanes from C-1 to C-10. A common **"ane"** suffix identifies these compounds as alkanes. The names **methane** through **decane** should be memorized, since they constitute the root of many names. Fortunately, common numerical prefixes are used in naming chains of five or more carbon atoms.

Examples of Simple Unbranched Alkanes						
Name	**Molecular Formula**	**Structural Formula**		**Name**	**Molecular Formula**	**Structural Formula**
meth**ane**	CH_4	CH_4		hex**ane**	C_6H_{14}	$CH_3(CH_2)_4CH_3$
eth**ane**	C_2H_6	CH_3CH_3		hept**ane**	C_7H_{16}	$CH_3(CH_2)_5CH_3$
prop**ane**	C_3H_8	$CH_3CH_2CH_3$		oct**ane**	C_8H_{18}	$CH_3(CH_2)_6CH_3$
but**ane**	C_4H_{10}	$CH_3CH_2CH_2CH_3$		non**ane**	C_9H_{20}	$CH_3(CH_2)_7CH_3$
pent**ane**	C_5H_{12}	$CH_3(CH_2)_3CH_3$		dec**ane**	$C_{10}H_{22}$	$CH_3(CH_2)_8CH_3$

Examples of some common **alkyl groups** are given in the following table. Note that the "ane" suffix is replaced by "**yl**" in naming groups. The symbol **R** is used to designate a generic (unspecified) alkyl group

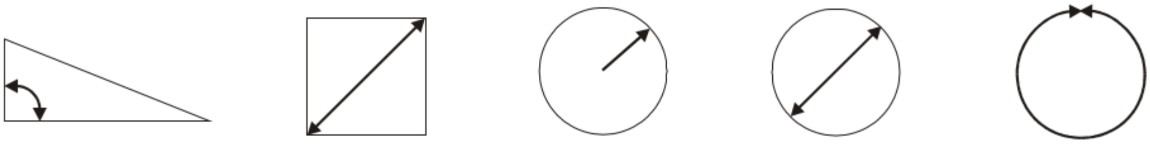
group	$CH_3–$	$C_2H_5–$	$CH_3CH_2CH_2–$	$(CH_3)_2CH–$	$CH_3CH_2CH_2CH_2–$	$(CH_3)_2CHCH_2–$	$CH_3CH_2CH(CH_3)–$	$(CH_3)_3C–$	R–
Name	Methyl	Ethyl	Propyl	Isopropyl	Butyl	Isobutyl	*sec*-Butyl	*tert*-Butyl	Alkyl

03- Geometry Shapes

triangle **square** **rectangle** **circle** **ellipsis/oval** **semi-circle**

It is a triangle. It is triangular in shape. It is elliptic(al)/ oval.

It is square. It is rectangular.

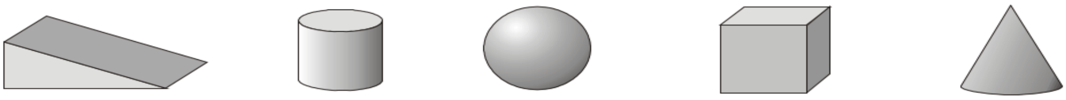


angle **diagonal** **radius** **diameter** **circumference**

Three dimensional

Prism

triangular prism **rectangular prism**



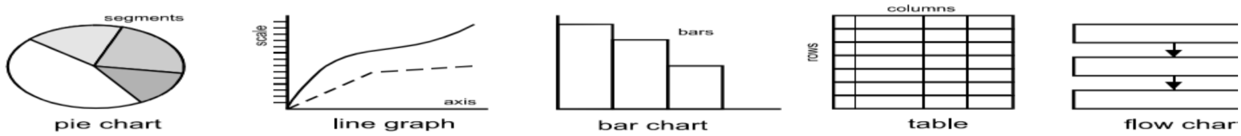
wedge
wedge-like

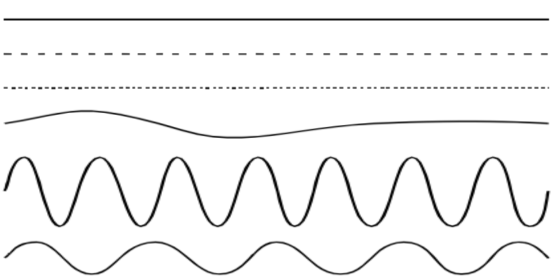
cylinder
cylindrical

sphere
spherical

cube
cubic(al)

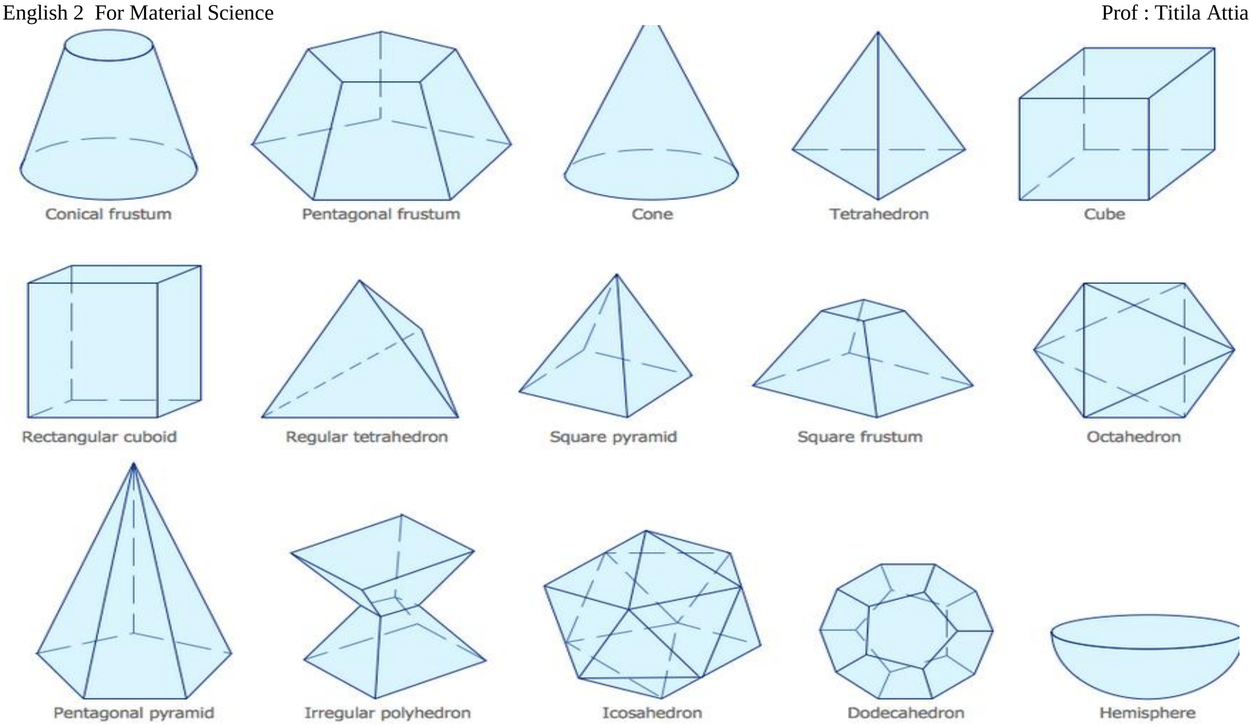
cone
conical



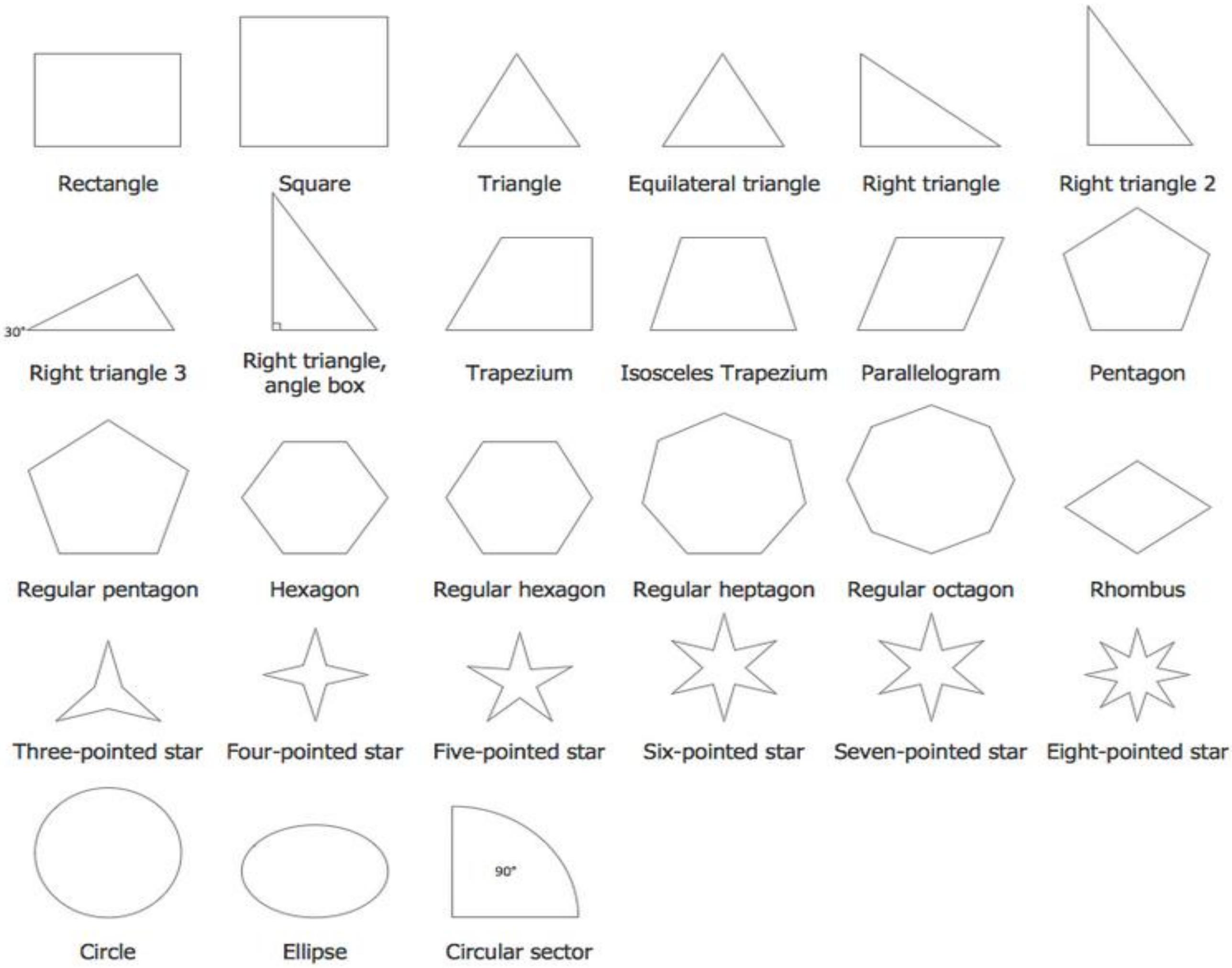


straight line
interrupted line
dotted line
curved line
oscillations/fluctuations
undulations

Trigonometric figures



Plane Geometry figures.



04- Physics equations

Word equation	Symbol equation
weight = mass × gravitational field strength (g)	$W = m\,g$
work done = force × distance (along the line of action of the force)	$W = F\,s$
force applied to a spring = spring constant × extension	$F = k\,e$
moment of a force = force × distance (normal to direction of force)	$M = F\,d$
pressure = $\frac{\text{force normal to a surface}}{\text{area of that surface}}$	$p = \frac{F}{A}$
distance travelled = speed × time	$s = v\,t$
acceleration = $\frac{\text{change in velocity}}{\text{time taken}}$	$a = \frac{\Delta v}{t}$
resultant force = mass × acceleration	$F = m\,a$
momentum = mass × velocity	$p = m\,v$
kinetic energy = 0.5 × mass × $(\text{speed})^2$	$E_k = \frac{1}{2} m\,v^2$
gravitational potential energy = mass × gravitational field strength (g) × height	$E_p = m\,g\,h$
power = $\frac{\text{energy transferred}}{\text{time}}$	$P = \frac{E}{t}$
power = $\frac{\text{work done}}{\text{time}}$	$P = \frac{W}{t}$
efficiency = $\frac{\text{useful output energy transfer}}{\text{total input energy transfer}}$	
efficiency = $\frac{\text{useful power output}}{\text{total power input}}$	
wave speed = frequency × wavelength	$v = f\,\lambda$
charge flow = current × time	$Q = I\,t$
potential difference = current × resistance	$V = I\,R$
power = potential difference × current	$P = V\,I$
power = $(\text{current})^2$ × resistance	$P = I^2\,R$
energy transferred = power × time	$E = P\,t$
energy transferred = charge flow × potential difference	$E = Q\,V$
density = $\frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{V}$

05- Talking The Present tenses Into A Redox Reaction

Here an example using the present tenses to explain how the chemical reaction of reduction/oxidation is happened. Try to read it with application of what you have learnt in the above course.

Redox **is** an acronym that **stands for** reduction/oxidation. During a chemical reaction, or equation, some reactants **are being transformed** into some products. We generally **associate** an oxidation state to the charge an atom would have if all bonds to atoms of different elements were 100% ionic. Thus the oxidation number **is connected** to the charge.

Let's consider, for instance, the molecule of sodium chloride. We know that sodium **is** an alkaline metal and that it **has** one valence electron in group I, while chlorine **is** an halogen of group VII that just **needs** 1 electron to have full 8 valence electrons in its shell.

Consequently, in the formation of NaCl, Na **is going to give** electrons and Cl **is going to get** them. As a result of this we can write Na+Cl-. Here Na+ **means** +1 charge because the sodium **is giving** the electron, while Cl- **mean**s -1 charge because the chlorine **is getting** it. The bond **is** ionic. But otherwise, if the bond is covalent, we'd better focus on partial positive or negative charges. In the formation of the molecule of water, the oxygen **is gaining** 2 electrons from the 2 hydrogens, which **are losing** them, the Hs being more electropositive and the O being more electronegative.

Consequently the oxidation number of hydrogen in H20 **is** +1, while the oxygen's **is** -1. As a result of this we can say that in a molecule of water the hydrogen **are oxidized** by the oxygen: the electrons **are taken away** from them, so that they **have** a positive charge. Now, let's study the following combustion:
CH4 + 2O2 → CO2 + 2H20

Here a molecule of methane **is reacting** with two molecules of oxygen in order to produce a molecule of carbon dioxide plus 2 molecules of water plus some heat (being esothermic, the reaction **produces** more heat than you put into it).

In CH4 an atom of carbon **is bounded** with 4 hydrogens. While reacting, being more electronegative, the carbon **is taking** 4 electrons from the hydrogens, so its charge **is going** down by four. As a result its oxidation number **is** -4 , while the hydrogen's **is** +1. Thus, we can write C-4H+1. In CO2, the carbon's oxidation state **is** +4, which **means** that it **is giving up** 4 electrons, and really it only **has** 2 electrons to give up, for it **has** 4 electrons in its valence shell. So, what **is getting** oxidized and what **is getting** reduced? Let's write down the first half reactions: C-4 → C+4 + 8e-

Here carbon **is going** from an oxidation number of -4 on the left side of this equation, to an oxidation number of +4 on the right side: 8 electrons **are being taken away** from carbon, so it **is being oxidized**.
As for the second half reaction 4O + 8e-→ 4O-2

we **have** 4 oxygens with a zero oxidation state (being in the elemental form) **turning into** 4 oxygens with a -2 oxidation state, so each of these oxygens **are taking** 4 e-, the two of them, so that there **are** 8e-. The oxidation state, that is the hypothetical charge, **is going down**, or it i**s being reduced** by carbon, as well as the carbon above **is being oxidized** by oxygen. Finally, what's the oxidizing agent, what is the thing that is oxidizing? Of course the oxygen is the oxidizing agent, while carbon is the reducing agent. Redox can also be reviewed from a biological point-of-view. Biologists **usually say** oxidation **deals with** losing hydrogen atoms, while reduction **deals with** gaining hydrogen atoms, though the essential meaning **stays** the same.

The reactions within cells which result in the ATP (adenosine triphosphate) synthase using energy stored in glucose **are referred to** as cellular respiration. It **requires** oxygen as the final electron acceptor. The equation for aerobic respiration **is** C6H12O6 + 6O2 → 6CO2 + 6 H2O + energy

Here we **are combining** glucose with molecular oxygen so that cellular respiration **is being performed**. We **end up** with 6 carbon dioxides and six molecules of water, while the energy produced **is made up** of some heat and about 38 ATPs. Glucose **is completely broken down** to CO2 + H2O though, during fermentation, it **is only partially broken down**.
Let’s take a look at the half reactions: H12 → 6 H2 (read: Hydrogen 12 **yielding** to 6 hydrogens 2) **says** the hydrogen **preserves** a +1 oxidation number (o.n.) on both sides of the equation so that nothing **is happening** with respect to oxidation and reduction, while C6 → 6C + 24e- **shows** the number of electrons lost by carbon in cellular respiration, the carbon **being oxidized** by the oxygen. Finally, O6 + 6O2 + 24e- → 6O2 + 6O **emphasizes** the fact that these 24 electrons are the same electrons carbon **is losing**, so that oxygen, which **is gaining**electrons, **is being reduced by carbon**.

Hence, where **does the energy come from**? The energy **is produced** because the electrons **are going** from a higher energy state, or level, to a lower one (we know that lower orbitals are more stable):
C6H12O6 + 6O2 → 6CO2 + 6 H2O↕ ↕ ↘ ↙ Oxidized reduced e- **are going** to these oxygens that is to say carbon **is losing** hydrogens, while oxygen **is gaining** hydrogens,