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# Technical English

## Civil Engineering and Construction

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# Vorwort

Das Lehrwerk **“Technical English – Civil Engineering and Construction”** ist als Text- und Arbeitsbuch für Studierende eines Ingenieurstudiengangs an Hochschulen konzipiert, die ihre allgemeinen Englischkenntnisse mit entsprechender fachsprachlicher Terminologie vorzugsweise aus dem Bauingenieurwesen und verwandter Disziplinen verbessern und ergänzen möchten.

In **acht Modulen** werden Themen aus den Bereichen **„Mathematics, Physics, Chemistry, Building Materials, The Construction Site, Energy, Surveying und Jobs in the Building Industry“** behandelt. Diese Themen zielen auf die naturwissenschaftlichen und fachspezifischen Module ab, die im Allgemeinen für ein **Bachelorstudium im Bauingenieurwesen** relevant sind. Diese Module können nacheinander, aber auch einzeln und in beliebiger Reihenfolge bearbeitet werden.

Die **didaktische und methodische Vorgehensweise** des Buches richtet sich nicht nach sprachlich ansteigenden Schwierigkeitsgraden, sondern wird hauptsächlich durch die Inhalte bestimmt. Methodisch ist das Buch in Textteile und diverse Übungen (Tasks) zur Einübung der Terminologie gegliedert. Durch eine reiche Bebilderung, Tabellen und Flowcharts usw. werden die Inhalte des Buches sehr gut veranschaulicht.

Ausgewählte **Grammatikkapitel** (Grammar Boxes) sowie kurze Übungen dazu dienen der Auffrischung gängiger grammatischer Gebiete, erheben aber keinen Anspruch auf Vollständigkeit. Sie wurden mit den Inhalten der Module abgestimmt.

Eine **Vokabelliste** nach jedem Modul, die ausführliche Vokabelliste am Ende des Buches sowie die online zur Verfügung stehenden **Lösungsvorschläge** machen das Buch für die Arbeit im **Seminarbereich** als auch für ein **Selbststudium** für solche Lerner geeignet, die sich idealerweise auf dem Übergang von **Level B2** zu **Level C1** des **„Gemeinsamen europäischen Referenzrahmen für Sprachen“** befinden und ihre fachspezifischen Englischkenntnisse weiter ausbauen möchten.

Während der Arbeit an diesem Lehrwerk haben zahlreiche Personen mit Rat und Tat hilfreich zur Seite gestanden; ihnen allen möchten wir hiermit danken. Besonderer Dank der Autorin aber gilt den **Studierenden** an der **Technischen Fachhochschule Georg Agricola**, die sie in ihren Seminaren mit Vorschlägen, aber auch mit Kritik zu Themen und Inhalten unterstützt haben.

Für konstruktive Kritik, aber auch für Lob zu diesem Lehrwerk sind wir immer offen und nehmen diese unter [lektorat@europa-lehrmittel.de](mailto:lektorat@europa-lehrmittel.de) dankbar entgegen.

Frühjahr 2013

Autorin und Verlag

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# 1 Mathematics

## 1.1 Numbers and Simple Calculations

In relation to other sciences, **mathematics** is of fundamental importance to all technicians and engineers. Scientists need to be familiar with numbers, figures, mathematical signs, symbols and terms. In **algebra**, you use letters and symbols to express a relationship and in **geometry** you have different figures, shapes and angles. With mathematical terms, one can describe rules, structures, quantities and change. As an engineering student, you are probably well acquainted with all types of calculation; from pure mathematics to **applied mathematics in physics** or **computational mathematics in information technology**. Now you are required to express equations, values and quantities in English.

### Notice!

#### Main differences in writing and reading English and German numbers

##### Cardinal Numbers

- Tens and ones are separated by a dash.
- The word "and" follows "hundred" when written in full.
- Thousands are separated by a comma.

##### Example:

- 44 forty-four
- 215 two hundred and fifteen
- 1,306 one thousand, three hundred and six

### TASK 1

Write in English.

##### Cardinal Numbers

- 21
- 105
- 4,444

•

•

•

##### Ordinal Numbers

- the first
- the second
- the third
- the fourth
- the fifth
- the sixth
- the nth

- 1st
- 2nd
- 3rd
- 4th
- 5th
- 6th
- nth



Pict. 1: Galileo Galilei 1594–1642, mathematician

### Notice!

#### Mind the Spelling

five/fifth

nine/ninth

twelve/twelfth

**TASK 2**

Name three numbers and practice their spelling. Write in full.

- |                   |     |       |           |       |
|-------------------|-----|-------|-----------|-------|
| 1. Even numbers   | 6,  | ..... | six,      | ..... |
| 2. Odd numbers    | 3,  | ..... | three,    | ..... |
| 3. Prime numbers  | 13, | ..... | thirteen, | ..... |
| 4. Square numbers | 4,  | ..... | four,     | ..... |
| 5. Cube numbers   | 9,  | ..... | nine,     | ..... |

**TASK 3**

Read the property values of nickel and then write the values of lead in full.

**Properties of Nickel**

Atomic number	28
Density	8.90 kg/dm <sup>3</sup>
Melting temperature	1453 °C
Thermal conductivity	90.5 W
Tensile strength	370 ... 700 N/mm <sup>2</sup>
Yield strength	70 MPa
Elastic modulus	197... 225 GPa
Elongation at fracture	28 %

The atomic number/density etc. of nickel is ...

- twenty-eight
- eight point nine zero kilograms per cubic decimetre / per decimetre cubed
- one thousand four hundred and fifty-three degrees Celsius
- ninety point five watts
- from three hundred and seventy to seven hundred newtons per square millimetre
- seventy megapascals
- from one hundred and ninety-seven to two hundred and twenty-five gigapascals
- twenty-eight per cent

**Properties of Lead**

Atomic number	82
Density	11.3 kg/dm <sup>3</sup>
Melting temperature	327 °C
Thermal conductivity	35.2 W
Tensile strength	10 ... 20 N/mm <sup>2</sup>
Yield strength	7... 8 MPa
Elastic modulus	17.5 GPa
Elongation at fracture	max. 50 %

Complete in the same way.

1. ....
2. ....
3. ....
4. ....
5. ....
6. ....
7. ....
8. ....



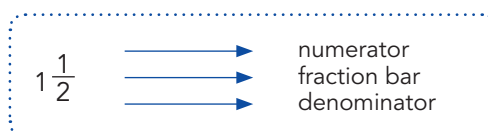
## 1.2 Fractions, Powers, Roots

### Fractions

consist of a numerator (above the fraction bar) and a denominator (below the fraction bar). Fractions can be simple ( $\frac{1}{2}$ ) or mixed ( $1\frac{1}{2}$ ). You can do arithmetic calculations with fractions, i.e. you can add, subtract, multiply, divide or even cancel fractions.

Example:

$\frac{1}{2}$  a half  
 $\frac{1}{3}$  a third  
 $\frac{1}{4}$  a quarter  
 $\frac{2}{5}$  two fifths



### Powers

mean to raise the value of a number to an exponent. Exponents allow us to write multiplications in short.

Example:

$$a^n = y$$

$a$  is the base  
 $n$  is the exponent  
 $y$  is the exponential value  
 $x^2$  means  $x$  is raised to the power of two, or  $x$  is squared  
 $x^3$  means  $x$  is raised to the power of three, or  $x$  is cubed



Pict. 1: René Descartes  
1596–1650,  
mathematician/philosopher

### Notice!

Numbers with negative exponents can also be written as fractions. The base is then given a positive exponent and is placed as the denominator.

Example:

$$x^{-2} = \frac{1}{x^2}$$

### Roots

are written with a radical sign  $\sqrt{\quad}$ . You can have a square root, a cube root or the  $n$ th root of a number.



Pict. 2: Gottfried W. Leibniz  
1646–1716,  
mathematician

### Powers of ten

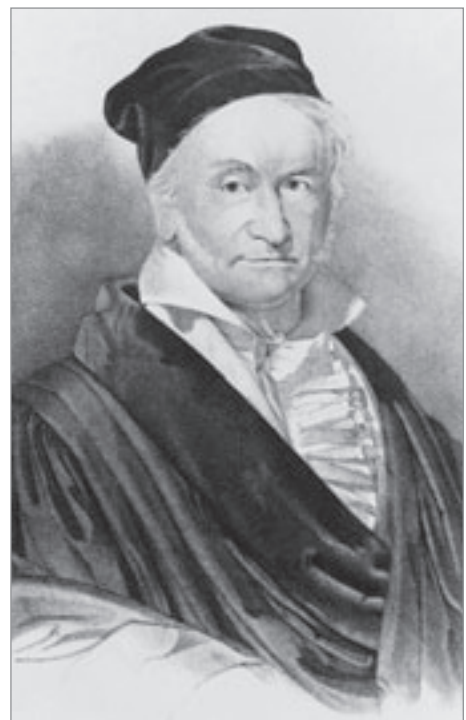
Positive numbers greater than 1 are expressed with a positive exponent and positive numbers less than 1 are expressed with a negative exponent.

Name	Multiplication factor	Power of ten	Affix / Abbreviation
billion	1,000,000,000	$10^9$	giga / G
million	1,000,000	$10^6$	mega / M
thousand	1,000	$10^3$	kilo / k
hundred	100	$10^2$	hecto / h
ten	10	$10^1$	deca / da
one	1	$10^0$	
tenth	0.1	$10^{-1}$	deci
hundredth	0.01	$10^{-2}$	centi
thousandth	0.001	$10^{-3}$	milli
millionth	0.000 001	$10^{-6}$	micro
billionth	0.000 000 001	$10^{-9}$	nano

### TASK 1

Match the English to the German words.

- |                  |                          |                       |
|------------------|--------------------------|-----------------------|
| 1. equals sign   | <input type="checkbox"/> | a. Brüche             |
| 2. inequality    | <input type="checkbox"/> | b. Einer              |
| 3. fractions     | <input type="checkbox"/> | c. Aufrunden          |
| 4. integer       | <input type="checkbox"/> | d. Gleichheitszeichen |
| 5. tens          | <input type="checkbox"/> | e. leere Menge        |
| 6. denominator   | <input type="checkbox"/> | f. Nenner             |
| 7. rounding      | <input type="checkbox"/> | g. Zähler             |
| 8. null set      | <input type="checkbox"/> | h. Zehner             |
| 9. numerator     | <input type="checkbox"/> | i. Ungleichheit       |
| 10. ones         | <input type="checkbox"/> | j. ganze Zahl         |
| 11. radical sign | <input type="checkbox"/> | k. Quadratwurzel      |
| 12. square root  | <input type="checkbox"/> | l. Wurzelzeichen      |
| 13. odd number   | <input type="checkbox"/> | m. gerade Zahl        |
| 14. even number  | <input type="checkbox"/> | n. ungerade Zahl      |



Pict. 1: Carl Friedrich Gauss 1777–1855, mathematician

## TASK 2

Complete the table for these basic mathematical calculations.

Operation	Verb	Example	Written in full:
addition	to add	$5 + 4 = 9$	1. Five plus four equals (or: is equal to) nine. ..... .....
subtraction	to subtract	$45 - 5 = 40$	2. ..... .....
multiplication	to multiply by / times	$50 \cdot 5 = 250$	3. ..... .....
division	to divide by	$55 : 5 = 11$	4. ..... .....
fraction	to calculate the fraction	$2\frac{3}{4}, 4\frac{2}{9}$	5. ..... .....
root extraction	to extract the root	$\sqrt{4}, \sqrt[3]{27}, \sqrt[4]{16}$	6. ..... .....
power	to raise to a power	$x^2, x^3, x^4, x^n$	7. ..... .....

## Signs and Symbols

Using signs and symbols, you can express whether a value is greater than or less than, equal to or only approximately equal to another value. A value can be written in brackets or can be within the limits of something.

### Mathematical Signs

>	greater than	∫	integral of
<	less than	≈	approximately equal to
≠	is not equal to, is unequal to	f(x)	the function of x
∑	sum of	x <sub>1</sub>	x sub one
x	the absolute value of x	( )	round brackets
n!	factorial n	[ ]	square brackets
%	percentage / per cent	{ }	braces, curly brackets
/	slash	x'	x prime

## Measurements

There is more than one type of measurement system existing, e.g. the traditional UK or imperial system and the metric system, which is a decimal system of measurement.

UK/US Units	Metric System
<b>Units of Length</b>	
1 inch	2.53 cm
1 foot	30.48 cm
1 yard	0.91 m
1 mile	1.6 km

UK/US Units	Metric System
<b>Units of Mass</b>	
1 ounce	28.35 g
1 (short) ton	0.9 t
1 pound	0.453 kg

UK/US Units	Metric System
<b>Units of Capacity</b>	
1 pint	0.568 l
1 quart = 2 pints	1.136 l
1 gallon = 8 pints	4.546 l



Pict. 1: Ruler [cm and inches]

**Notice!**

The imperial system and the US system use similar terms, but the relationships are not always the same:

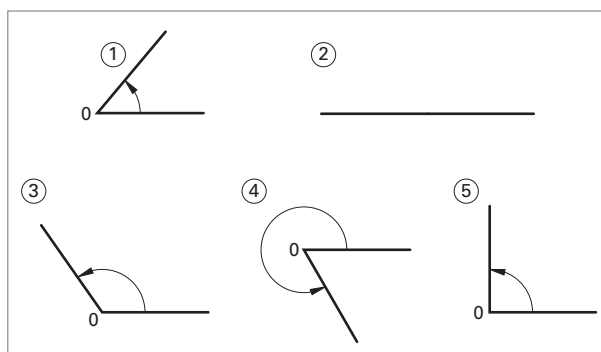
- 1 imperial gallon = 4.54 litres
- 1 imperial pint = 0.56 litres = 1.201 US pints
- 1 US gallon = 3.78 litres

## 1.3 Geometry

Geometry is a branch of mathematics that is concerned with the properties of angles, shapes, lines, curves, surfaces and solid objects.

### Angles

An angle may be  
 ① acute, ② flat,  
 ③ obtuse, ④ reflex or  
 ⑤ right.



Pict. 1: Angles

### TASK 1

#### Fill in.

1. An angle of  $90^\circ$  is a right angle. ....
2. An angle which equals  $180^\circ$  is a/an .....  
 .....
3. An angle which is less than  $90^\circ$  is a/an .....  
 .....
4. An angle which is greater than  $180^\circ$  is a/an .....  
 .....
5. An angle which is between  $90^\circ$  and  $180^\circ$  is a/an .....  
 .....

### Triangles

Triangles are geometric forms with three angles and three sides. They can be classified according to their sides or angles. Sides and angles can be calculated using the **Pythagoras' theorem**.

$$a^2 + b^2 = c^2$$

- a = side
- b = side
- c = hypotenuse

### TASK 2

Describe the Pythagorean theorem.

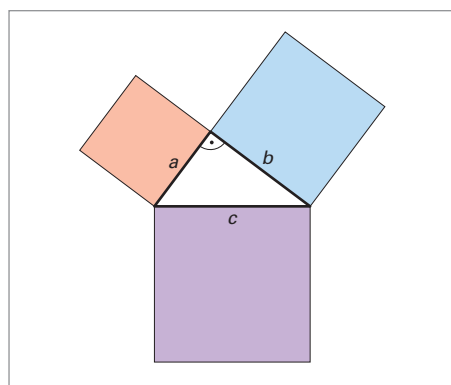
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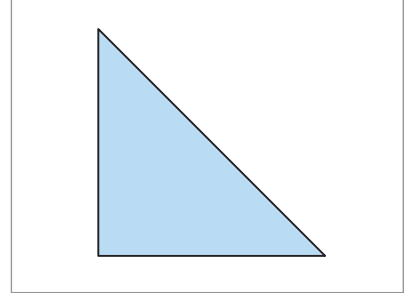
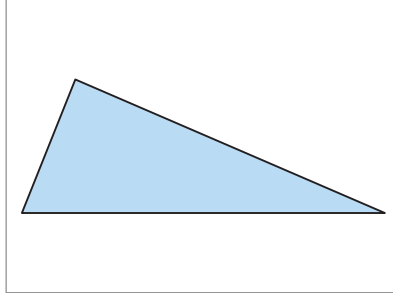
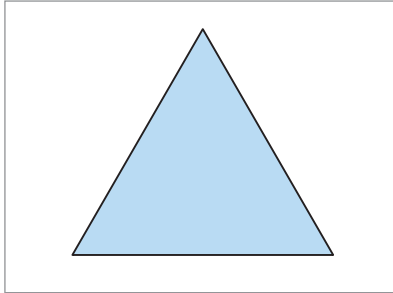
Pict. 2: The Pythagorean theorem

**Sides or Legs of Triangles**

A **scalene** triangle has three sides all with different lengths. An **isosceles** triangle has two sides or legs of equal length. In an **equilateral** triangle all sides are equal.

**TASK 3**

Name the triangle types.



1. ....

2. ....

3. ....

**2-D and 3-D Shapes**

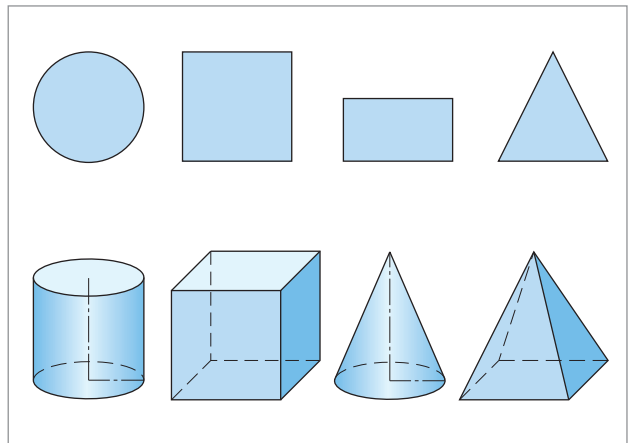
Objects have forms or shapes with different dimensions regarding length, width, height or depth. They can be drawn or presented in two or three dimensions. **Two dimensional shapes** (2-D) are flat forms with length and width. **Three dimensional shapes** (3-D) additionally have depth or thickness, as they are seen in reality.

**TASK 4**

Enter the words into the right columns.

*cone ... cube ... cylinder ... hexagon ... polygon ... prism  
pyramid ... rectangle ... sphere ... square ... triangle*

2-D Shapes	3-D Shapes
square	cube



Pict. 1: 2-D and 3-D Shapes

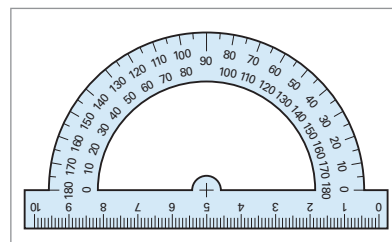
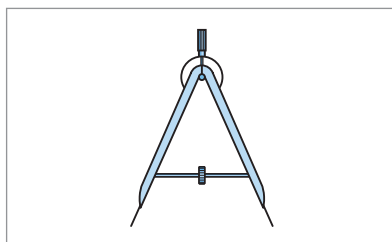
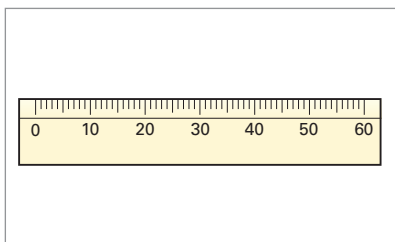
## A Geometric Set

Even if most engineering or technical drawings are done by computer simulations, **hand-held instruments** for drawing geometric figures are still in use.

### TASK 5

Match the words to the instruments.

*a pair of compasses ... protractor ... ruler*



1. .... 2. .... 3. ....

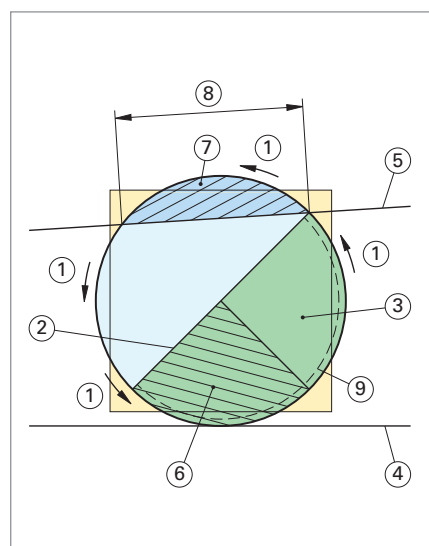
## Circles

Circles are round flat forms drawn with a pair of compasses. They can be divided into parts, e. g. radius, diameter, circumference etc. Each part can be calculated using the irrational number Pi ( $\pi$ ) which is 3.14.

### TASK 6

Translate into German.

English	German
1. circumference	.....
2. diameter	.....
3. semicircle	.....
4. tangent	.....
5. secant	.....
6. sector	.....
7. segment	.....
8. chord	.....
9. arc	.....



Pict. 1: Parts of a circle

**TASK 7**

Match the definitions to the parts of a circle.

*arc ... chord ... circumference ... diameter  
radius ... sector ... segment ... semicircle*

1. Its formula is  $\pi \cdot d$  or  $2\pi \cdot r$ , which is the total distance around the edge of a circle.
2. It is a portion of a curve or part of the circumference.
3. It is a straight line joining the centre of a circle to a point on its circumference.
4. It is twice the radius and a straight line through the centre of a circle.
5. It is part of a circle formed by two radii and the arc between them.
6. A half circle is a ...
7. It is a straight line linking two points on a circle or a curve.
8. It is a part of a circle which is separated from the rest by a chord across it.

.....

.....

.....

.....

.....

.....

.....

.....



## Vocabulary Module 1

<b>abbreviation</b>	Abkürzung	<b>letter</b>	Buchstabe
<b>acute (-angled)</b>	spitz (-winklig)	<b>melting temperature</b>	Schmelztemperatur
<b>add, to</b>	addieren	<b>metric system</b>	metrisches System
<b>affix</b>	Vorsatz, -silbe	<b>multiply, to</b>	multiplizieren
<b>angle</b>	Winkel	<b>number</b>	Zahl
<b>approximately</b>	ungefähr	<b>numerator</b>	Zähler
<b>arc</b>	Bogen	<b>obtuse (-angled)</b>	stumpf (-winklig)
<b>brace</b>	Klammer (math.)	<b>odd (number)</b>	ungerade (Zahl)
<b>bracket</b>	Klammer (math.)	<b>ordinal number</b>	Ordnungszahl
<b>branch</b>	Zweig	<b>ounce</b>	Unze (engl. Gewichtseinheit)
<b>cancel, to</b>	hier: kürzen	<b>pair of compasses</b>	Zirkel
<b>cardinal number</b>	Kardinalzahl	<b>polygon</b>	Vieleck
<b>chord</b>	Sehne	<b>power</b>	Potenz
<b>circle</b>	Kreis	<b>power of ten</b>	Zehnerpotenz
<b>circumference</b>	Umfang	<b>prime (number)</b>	Prim- (Zahl)
<b>cone</b>	Kegel	<b>proper(ly)</b>	richtig, genau
<b>cube</b>	Kubik-	<b>protractor</b>	Winkelmesser
<b>curly (bracket)</b>	geschweift(e) (Klammer)	<b>Pythagoras' theorem</b>	Satz des Pythagoras
<b>dash</b>	Bindestrich	<b>Pythagorean theorem</b>	Satz des Pythagoras
<b>denominator</b>	Nenner	<b>radical sign</b>	Wurzelzeichen
<b>density</b>	Dichte	<b>raise to the power, to</b>	potenzieren; ‚hoch‘
<b>depth</b>	Tiefe	<b>rectangle</b>	Rechteck
<b>diameter</b>	Durchmesser	<b>reflex (-angled)</b>	überstumpf
<b>dimension</b>	Abmessung	<b>relationship</b>	Verhältnis
<b>divide, to</b>	dividieren	<b>root</b>	Wurzel
<b>draw, to</b>	zeichnen	<b>root extraction</b>	Wurzelziehen
<b>elastic modulus</b>	Elastizitätsmodul	<b>ruler</b>	Lineal
<b>elongation at fracture</b>	Bruchdehnung	<b>scalene</b>	ungleichseitig
<b>enter, to</b>	einsetzen, einfügen	<b>sector</b>	Abschnitt
<b>equals sign</b>	Gleichheitszeichen	<b>shape</b>	Form
<b>equation</b>	Gleichung	<b>solid object</b>	Festkörper
<b>equilateral</b>	gleichseitig	<b>spelling</b>	Schreibweise
<b>even (number)</b>	gerade (Zahl)	<b>sphere</b>	Kugel
<b>even if</b>	selbst wenn	<b>square (number)</b>	Quadrat- (Zahl)
<b>figure</b>	Abbildung	<b>subtract, to</b>	subtrahieren
<b>flat</b>	flach	<b>surface</b>	Oberfläche
<b>foot</b>	Fuß (engl. Maßeinheit)	<b>technical drawing</b>	technische Zeichnung
<b>fraction</b>	Bruch	<b>tensile strength</b>	Zugfestigkeit
<b>fraction bar</b>	Bruchstrich	<b>thermal conductivity</b>	Wärmeleitfähigkeit
<b>geometric set</b>	Geozeichengerät	<b>thickness</b>	Dicke
<b>hand-held</b>	tragbar	<b>triangle</b>	Dreieck
<b>hexagon</b>	Sechseck	<b>value</b>	Wert
<b>imperial system</b>	Maßeinheitensystem in GB	<b>well acquainted with</b>	sich gut auskennen mit
<b>inch</b>	Zoll (engl. Maßeinheit)	<b>width</b>	Breite
<b>integer</b>	Ganzzahl	<b>yard</b>	Yard (engl. Maßeinheit)
<b>isosceles</b>	gleichschenkelig	<b>yield strength</b>	Streckgrenze
<b>leg</b>	Schenkel (Dreieck)		

# 2 Physics

## 2.1 Important Physical Quantities

**Physics** is the science of the properties and nature of matter. Natural processes, derived laws and results of physical measurements are described using specific terms, symbols, quantities and units. In physical processes, the form, the position, or the state of a body changes.

The form is changed, for example, when a piece of material is deformed, compressed or bent.

The position is changed, for example, when construction materials are stacked to create buildings.

The state of matter changes, for example, when water (a liquid), which is sprayed on hot stones, evaporates (becomes gaseous) because of rising temperatures.

## Volume, Mass, Density

**Volume:** Each body has a specific volume. The unit of volume is the cubic metre ( $\text{m}^3$ ).

**Mass:** Each body has a mass. The unit of mass is the kilogram ( $\text{kg}$ ).  
The mass of a static body is independent of the place where the body is.

**Density:** The relation of mass to volume. The unit of density is  $\text{kg}/\text{dm}^3$ .

### TASK 1

Fill in the gaps using the following words.

*density ... mass ... volume*

1. The ..... of an object depends on the mass and the volume. Different materials of the same mass mostly have different volumes.
2. Each object has a particular .....  
The unit of ..... is  $\text{m}^3$ .
3. The unit of ..... is the kilogram.
4. density = ...../volume
5. .... = volume · density
6. volume = mass/ .....



Pict. 1: Daniel Bernoulli 1700–1782, physicist

## Power, Work, Forces, Energy

Physics deals with forces, work, power and different forms of energy and its conversion. Power, work, forces and energy are not the same. Energy and power can be electrical or mechanical.

<b>Energy</b>	The ability to do work.	$E = Q \cdot V$
<b>Work</b>	The application of force to produce movement.	$W = F \cdot d$
<b>Power</b>	Work done in a period of time.	$P = W/t$
<b>Force</b>	Mass times acceleration.	$F = m \cdot a$

$Q$  = charge

$V$  = voltage

$d$  = distance



Pict. 1: Alessandro Volta 1745–1827, physicist

### TASK 2

Test your knowledge. Complete the table below. Use the following units.

*hertz ... joules ... newtons ... ohms ... pascals ... volts ... watts*

Quantity	Measured in	Formula	Written in full
energy	joules	$E = Q \cdot V$	energy equals charge times voltage
pressure			
work			
force			
power			
frequency			
resistance			
potential difference			

In physics, the unit of energy is the "joule". Energy can be different in form and type. We may have potential or kinetic energy as well as electrical, heat or light energy. Energy cannot be destroyed, but transformed from one form to the other.

## Milestones in Physics

Mankind has been inventing things throughout history. However, from the 16th century onwards, findings and developments could be explained on a more precise or scientific level. A real age of discovery started when those findings were translated into laws.

Motion, gravitation, electric or magnetic forces, the transfer of heat and electricity and the behaviour of gases, all belong to the field of physics.

Even though we know a lot about the physical nature of atoms, atomic or nuclear physics is still a vast field to be discovered. The following table gives a short overview of the **history of physics** from the 16th century onwards. Most of the scientific developments and inventions mentioned here, such as Ohm's law on the relationship of current, voltage and resistance, are still important today.

Dates	Physicist	Discovery, Invention or Development
1594 – 1642	Galilei	Experimental work on the motion of bodies and free fall of objects; pendulum motion and theory of elasticity
1602 – 1686	Guericke	Physics of vacuum, experiment with two hemispheres sticking together because of vacuum; invention of vacuum pump
1642 – 1726	Newton	Differential and integral calculus; laws of motion; theory of gravitation; apple analogy
1700 – 1782	Bernoulli	Bernoulli's principle of aerodynamics and hydrodynamics; kinetic theory of gases
1736 – 1806	Coulomb	Electricity and magnetism; laws of friction, soil mechanics
1745 – 1827	Volta	Electric cell; electrolyte as a conductor of electricity
1789 – 1854	Ohm	Ohm's law on electrical resistance
1791 – 1867	Faraday	Electromagnetism; electromagnetic rotation and induction
1824 – 1907	Kelvin	Thermodynamics; electricity
1845 – 1923	Röntgen	X-ray; 1901 Nobel Prize in Physics
1852 – 1908	Becquerel	Discovery of radioactivity; 1903 Nobel Prize in Physics
1857 – 1894	Hertz	Electromagnetic waves
1879 – 1955	Einstein	Theory of gravitation; theory of relativity; 1921 Nobel Prize in physics



Pict. 1: Georg Simon Ohm



Pict. 2: William Thomson Kelvin



Pict. 3: Wilhelm Conrad Röntgen