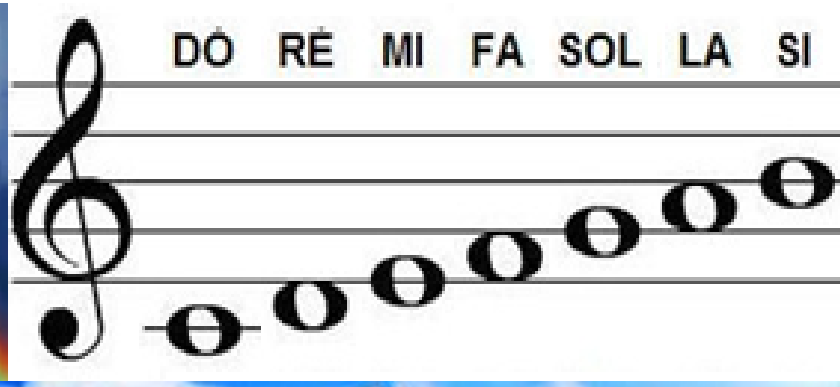
ENGENHARIA DE BIOSSISTEMAS – FZEA / USP

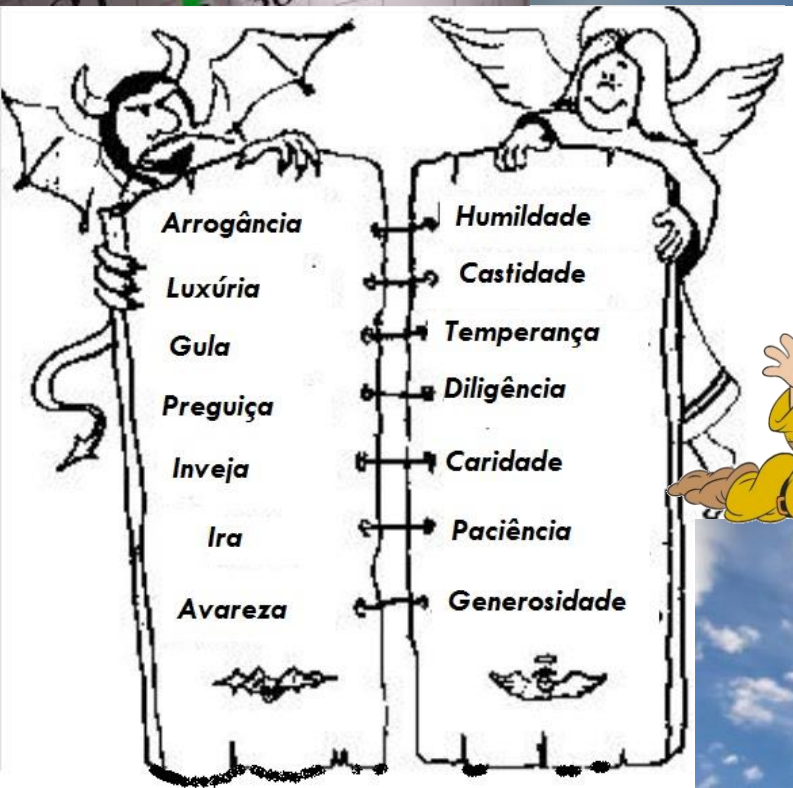
ZEB1027 FENÔMENOS DE TRANSPORTE

SCALE-UP E SEMELHANÇA: GRANDEZAS E UNIDADES

- GRANDEZAS FÍSICAS FUNDAMENTAIS
- GRANDEZAS FÍSICAS DERIVADAS
- UNIDADES NO SISTEMA INTERNACIONAL

Grandezas físicas fundamentais





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Grandezas físicas fundamentais

M : Massa

T : Tempo

L : Comprimento

I : Corrente elétrica

Θ : Temperatura

J : Intensidade luminosa

N : Quantidade de matéria

Grandezas físicas fundamentais

TODAS as grandezas físicas derivadas

"Versores ortogonais no espaço vetorial das grandezas físicas"

- **M : Massa**
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Grandezas fundamentais: unidades SI

Table 1.1 SI Base Units

Measurable attribute of phenomena or matter	Name	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Amount of substance	mole	mol
Luminous intensity	candela	cd

Grandezas derivadas: unidades SI

Table 1.2 Examples of SI Derived Units Expressed in Terms of Base Units

Quantity	SI unit	
	Name	Symbol
Area	square meter	m^2
Volume	cubic meter	m^3
Speed, velocity	meter per second	m/s
Acceleration	meter per second squared	m/s^2
Density, mass density	kilogram per cubic meter	kg/m^3
Current density	ampere per square meter	A/m^2
Magnetic field strength	ampere per meter	A/m
Concentration (of amount of substance)	mole per cubic meter	mol/m^3
Specific volume	cubic meter per kilogram	m^3/kg
Luminance	candela per square meter	cd/m^2

Grandezas derivadas: unidades SI

Table 1.3 Examples of SI Derived Units with Special Names

Quantity	SI unit			
	Name	Symbol	Expression in terms of other units	Expression in terms of SI base units
Frequency	hertz	Hz		s^{-1}
Force	newton	N		$m\ kg\ s^{-2}$
Pressure, stress	pascal	Pa	N/m^2	$m^{-1}\ kg\ s^{-2}$
Energy, work, quantity of heat	joule	J	N m	$m^2\ kg\ s^{-2}$
Power, radiant flux	watt	W	J/s	$m^2\ kg\ s^{-3}$
Quantity of electricity, electric charge	coulomb	C		s A
Electric potential, potential difference, electromotive force	volt	V	W/A	$m^2\ kg\ s^{-3}\ A^{-1}$
Capacitance	farad	F	C/V	$m^{-2}\ kg^{-1}\ s^4\ A^2$
Electric resistance	ohm	Ω	V/A	$m^2\ kg\ s^{-3}\ A^{-2}$
Conductance	siemens	S	A/V	$m^{-2}\ kg^{-1}\ s^3\ A^2$
Celsius temperature	degree Celsius	°C		K
Luminous flux	lumen	lm		cd sr
Illuminance	lux	lx	lm/m^2	m^{-2} cd sr

Grandezas derivadas: unidades SI

Table 1.4 Examples of SI Derived Units Expressed by Means of Special Names

	SI unit		
Quantity	Name	Symbol	Expression in terms of SI base units
Dynamic viscosity	pascal second	Pa s	m^{-1} kg s^{-1}
Moment of force	newton meter	N m	m^2 kg s^{-2}
Surface tension	newton per meter	N/m	kg s^{-2}
Power density, heat flux density, irradiance	watt per square meter	W/m^2	kg s^{-3}
Heat capacity, entropy	joule per kelvin	J/K	m^2 kg s^{-2} K^{-1}
Specific heat capacity	joule per kilogram kelvin	J/(kg K)	m^2 s^{-2} K^{-1}
Specific energy	joule per kilogram	J/kg	m^2 s^{-2}
Thermal conductivity	watt per meter kelvin	W/(m K)	m kg s^{-3} K^{-1}
Energy density	joule per cubic meter	J/m^3	m^{-1} kg s^{-2}
Electric field strength	volt per meter	V/m	m kg s^{-3} A^{-1}
Electric charge density	coulomb per cubic meter	C/m^3	m^{-3} s A
Electric flux density	coulomb per square meter	C/m^2	m^{-2} s A