



# Reference Tables for Physical Setting/PHYSICS

## 2006 Edition

### List of Physical Constants

Name	Symbol	Value
Universal gravitational constant	$G$	$6.67 \times 10^{-11} \text{ N}\cdot\text{m}^2/\text{kg}^2$
Acceleration due to gravity	$g$	$9.81 \text{ m/s}^2$
Speed of light in a vacuum	$c$	$3.00 \times 10^8 \text{ m/s}$
Speed of sound in air at STP		$3.31 \times 10^2 \text{ m/s}$
Mass of Earth		$5.98 \times 10^{24} \text{ kg}$
Mass of the Moon		$7.35 \times 10^{22} \text{ kg}$
Mean radius of Earth		$6.37 \times 10^6 \text{ m}$
Mean radius of the Moon		$1.74 \times 10^6 \text{ m}$
Mean distance—Earth to the Moon		$3.84 \times 10^8 \text{ m}$
Mean distance—Earth to the Sun		$1.50 \times 10^{11} \text{ m}$
Electrostatic constant	$k$	$8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$
1 elementary charge	$e$	$1.60 \times 10^{-19} \text{ C}$
1 coulomb (C)		$6.25 \times 10^{18} \text{ elementary charges}$
1 electronvolt (eV)		$1.60 \times 10^{-19} \text{ J}$
Planck's constant	$h$	$6.63 \times 10^{-34} \text{ J}\cdot\text{s}$
1 universal mass unit (u)		$9.31 \times 10^2 \text{ MeV}$
Rest mass of the electron	$m_e$	$9.11 \times 10^{-31} \text{ kg}$
Rest mass of the proton	$m_p$	$1.67 \times 10^{-27} \text{ kg}$
Rest mass of the neutron	$m_n$	$1.67 \times 10^{-27} \text{ kg}$

### Prefixes for Powers of 10

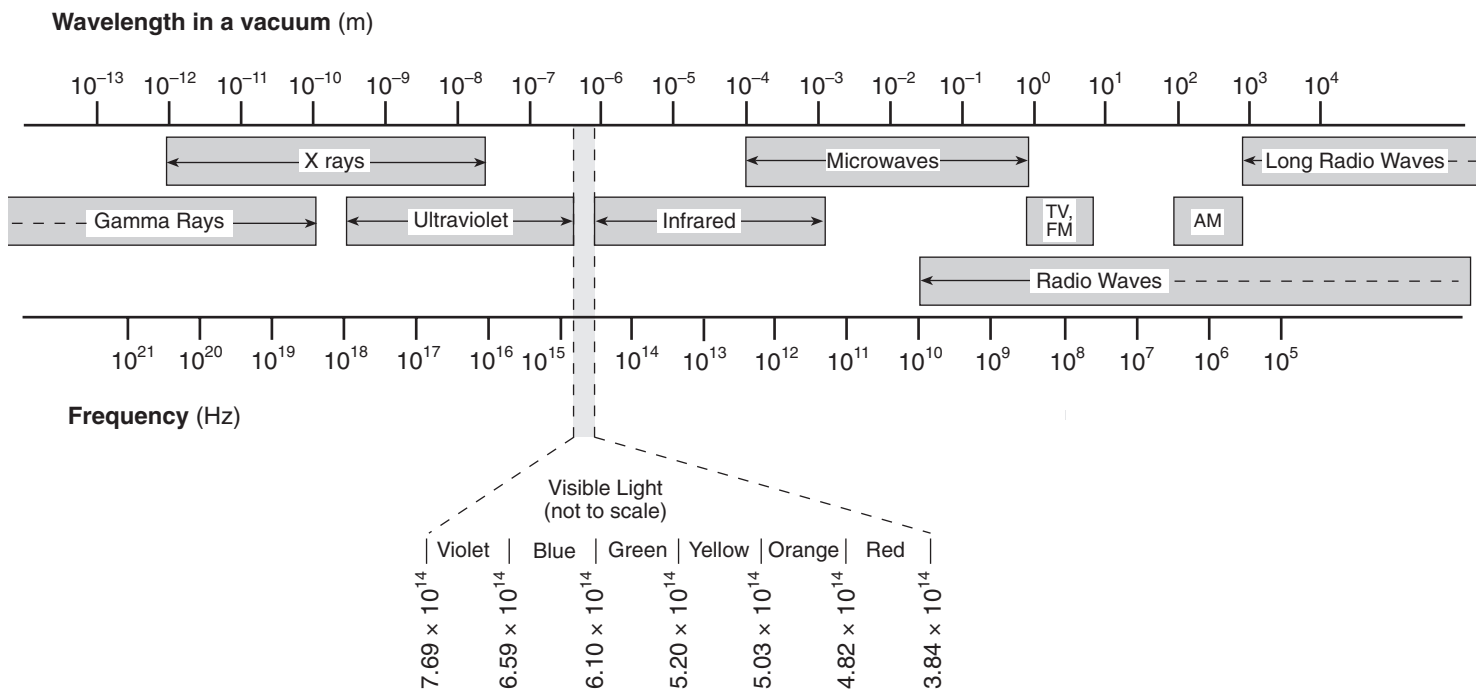
Prefix	Symbol	Notation
tera	T	$10^{12}$
giga	G	$10^9$
mega	M	$10^6$
kilo	k	$10^3$
deci	d	$10^{-1}$
centi	c	$10^{-2}$
milli	m	$10^{-3}$
micro	$\mu$	$10^{-6}$
nano	n	$10^{-9}$
pico	p	$10^{-12}$

### Approximate Coefficients of Friction

	Kinetic	Static
Rubber on concrete (dry)	0.68	0.90
Rubber on concrete (wet)	0.58	
Rubber on asphalt (dry)	0.67	0.85
Rubber on asphalt (wet)	0.53	
Rubber on ice	0.15	
Waxed ski on snow	0.05	0.14
Wood on wood	0.30	0.42
Steel on steel	0.57	0.74
Copper on steel	0.36	0.53
Teflon on Teflon	0.04	



# The Electromagnetic Spectrum



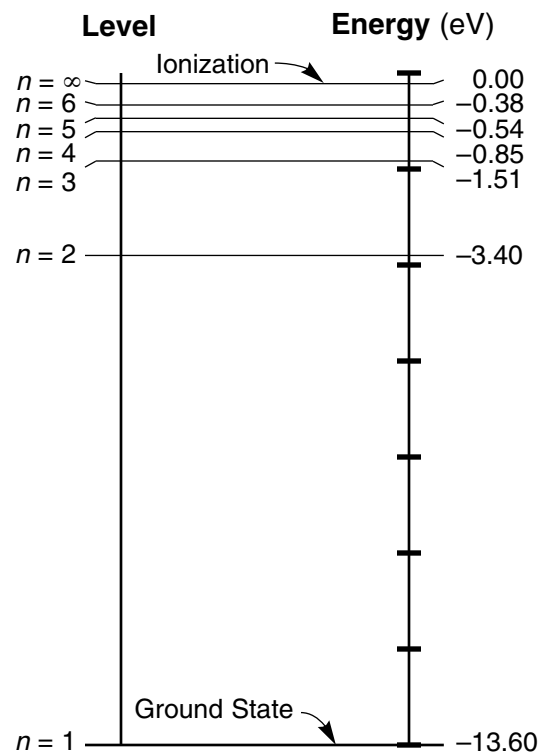
## Absolute Indices of Refraction

$$(f = 5.09 \times 10^{14} \text{ Hz})$$

Air	1.00
Corn oil	1.47
Diamond	2.42
Ethyl alcohol	1.36
Glass, crown	1.52
Glass, flint	1.66
Glycerol	1.47
Lucite	1.50
Quartz, fused	1.46
Sodium chloride	1.54
Water	1.33
Zircon	1.92

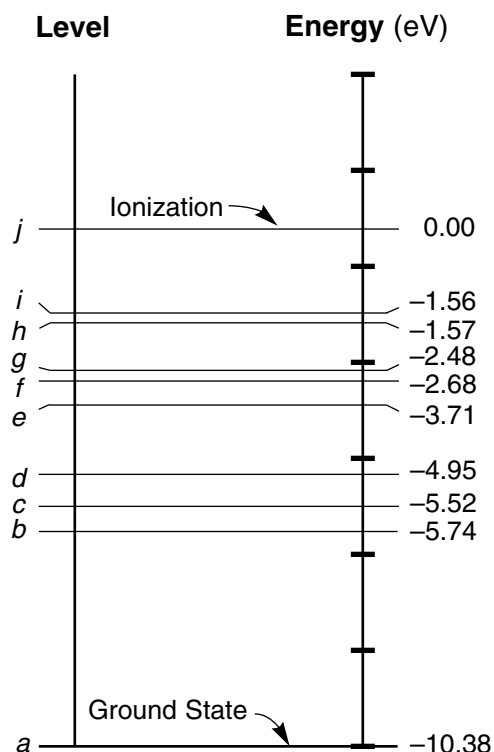
# Energy Level Diagrams

## Hydrogen



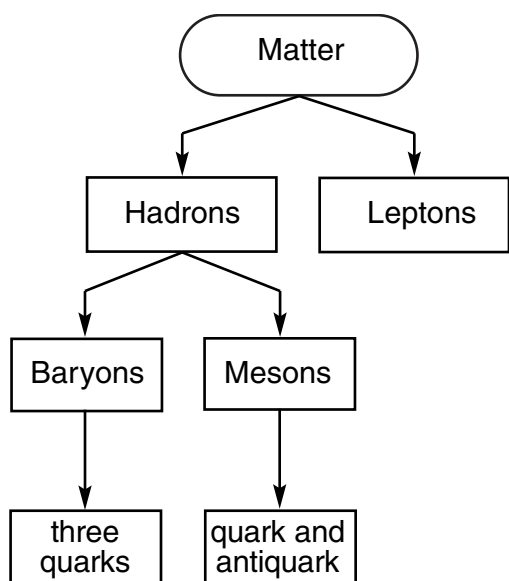
Energy Levels for the Hydrogen Atom

## Mercury



A Few Energy Levels for the Mercury Atom

## Classification of Matter



## Particles of the Standard Model

### Quarks

Name	Symbol	Charge
up	$u$	$+\frac{2}{3}e$
charm	$c$	$+\frac{2}{3}e$
top	$t$	$+\frac{2}{3}e$
down	$d$	$-\frac{1}{3}e$
strange	$s$	$-\frac{1}{3}e$
bottom	$b$	$-\frac{1}{3}e$

### Leptons

electron	$e$	$-1e$
muon	$\mu$	$-1e$
tau	$\tau$	$-1e$
electron neutrino	$\nu_e$	0
muon neutrino	$\nu_\mu$	0
tau neutrino	$\nu_\tau$	0

**Note:** For each particle, there is a corresponding antiparticle with a charge opposite that of its associated particle.

## Electricity

$$F_e = \frac{kq_1q_2}{r^2}$$

$$E = \frac{F_e}{q}$$

$$V = \frac{W}{q}$$

$$I = \frac{\Delta q}{t}$$

$$R = \frac{V}{I}$$

$$R = \frac{\rho L}{A}$$

$$P = VI = I^2R = \frac{V^2}{R}$$

$$W = Pt = VIt = I^2Rt = \frac{V^2t}{R}$$

$A$  = cross-sectional area

$E$  = electric field strength

$F_e$  = electrostatic force

$I$  = current

$k$  = electrostatic constant

$L$  = length of conductor

$P$  = electrical power

$q$  = charge

$R$  = resistance

$R_{eq}$  = equivalent resistance

$r$  = distance between centers

$t$  = time

$V$  = potential difference

$W$  = work (electrical energy)

$\Delta$  = change

$\rho$  = resistivity

### Series Circuits

$$I = I_1 = I_2 = I_3 = \dots$$

$$V = V_1 + V_2 + V_3 + \dots$$

$$R_{eq} = R_1 + R_2 + R_3 + \dots$$


### Parallel Circuits


$$I = I_1 + I_2 + I_3 + \dots$$

$$V = V_1 = V_2 = V_3 = \dots$$


$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$$


### Circuit Symbols

 cell


 battery

 switch

 voltmeter

 ammeter

 resistor

 variable resistor

 lamp

Resistivities at 20°C	
Material	Resistivity ( $\Omega \cdot m$ )
Aluminum	$2.82 \times 10^{-8}$
Copper	$1.72 \times 10^{-8}$
Gold	$2.44 \times 10^{-8}$
Nichrome	$150. \times 10^{-8}$
Silver	$1.59 \times 10^{-8}$
Tungsten	$5.60 \times 10^{-8}$

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## Waves

$$v = f\lambda$$

$$T = \frac{1}{f}$$

$$\theta_i = \theta_r$$

$$n = \frac{c}{v}$$

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

$$\frac{n_2}{n_1} = \frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2}$$

$c$  = speed of light in a vacuum

$f$  = frequency

$n$  = absolute index of refraction

$T$  = period

$v$  = velocity or speed

$\lambda$  = wavelength

$\theta$  = angle

$\theta_i$  = angle of incidence

$\theta_r$  = angle of reflection

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## Modern Physics

$$E_{\text{photon}} = hf = \frac{hc}{\lambda}$$

$$E_{\text{photon}} = E_i - E_f$$

$$E = mc^2$$

$c$  = speed of light in a vacuum

$E$  = energy

$f$  = frequency

$h$  = Planck's constant

$m$  = mass

$\lambda$  = wavelength

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## Geometry and Trigonometry

### Rectangle

$$A = bh$$

$A$  = area

$b$  = base

### Triangle

$$A = \frac{1}{2}bh$$

$C$  = circumference

$h$  = height

$r$  = radius

### Circle

$$A = \pi r^2$$

$$C = 2\pi r$$

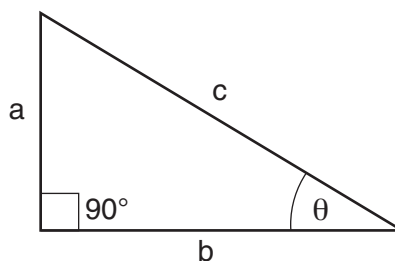
### Right Triangle

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

$$\sin \theta = \frac{a}{c}$$

$$\cos \theta = \frac{b}{c}$$

$$\tan \theta = \frac{a}{b}$$



## Mechanics

$$\bar{v} = \frac{d}{t}$$

$$a = \frac{\Delta v}{t}$$

$$v_f = v_i + at$$

$$d = v_i t + \frac{1}{2} at^2$$

$$v_f^2 = v_i^2 + 2ad$$

$$A_y = A \sin \theta$$

$$A_x = A \cos \theta$$

$$a = \frac{F_{net}}{m}$$

$$F_f = \mu F_N$$

$$F_g = \frac{Gm_1m_2}{r^2}$$

$$g = \frac{F_g}{m}$$

$$p = mv$$

$$p_{before} = p_{after}$$

$$J = F_{net} t = \Delta p$$

$$F_s = kx$$

$$PE_s = \frac{1}{2} kx^2$$

$$F_c = ma_c$$

$$a_c = \frac{v^2}{r}$$

$$\Delta PE = mg\Delta h$$

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

$$W = Fd = \Delta E_T$$

$$E_T = PE + KE + Q$$

$$P = \frac{W}{t} = \frac{Fd}{t} = F\bar{v}$$

$a$  = acceleration

$a_c$  = centripetal acceleration

$A$  = any vector quantity

$d$  = displacement or distance

$E_T$  = total energy

$F$  = force

$F_c$  = centripetal force

$F_f$  = force of friction

$F_g$  = weight or force due to gravity

$F_N$  = normal force

$F_{net}$  = net force

$F_s$  = force on a spring

$g$  = acceleration due to gravity or  
gravitational field strength

$G$  = universal gravitational constant

$h$  = height

$J$  = impulse

$k$  = spring constant

$KE$  = kinetic energy

$m$  = mass

$p$  = momentum

$P$  = power

$PE$  = potential energy

$PE_s$  = potential energy stored in a spring

$Q$  = internal energy

$r$  = radius or distance between centers

$t$  = time interval

$v$  = velocity or speed

$\bar{v}$  = average velocity or average speed

$W$  = work

$x$  = change in spring length from the  
equilibrium position

$\Delta$  = change

$\theta$  = angle

$\mu$  = coefficient of friction