

2002 Edition Reference Tables for Physical Setting/Physics

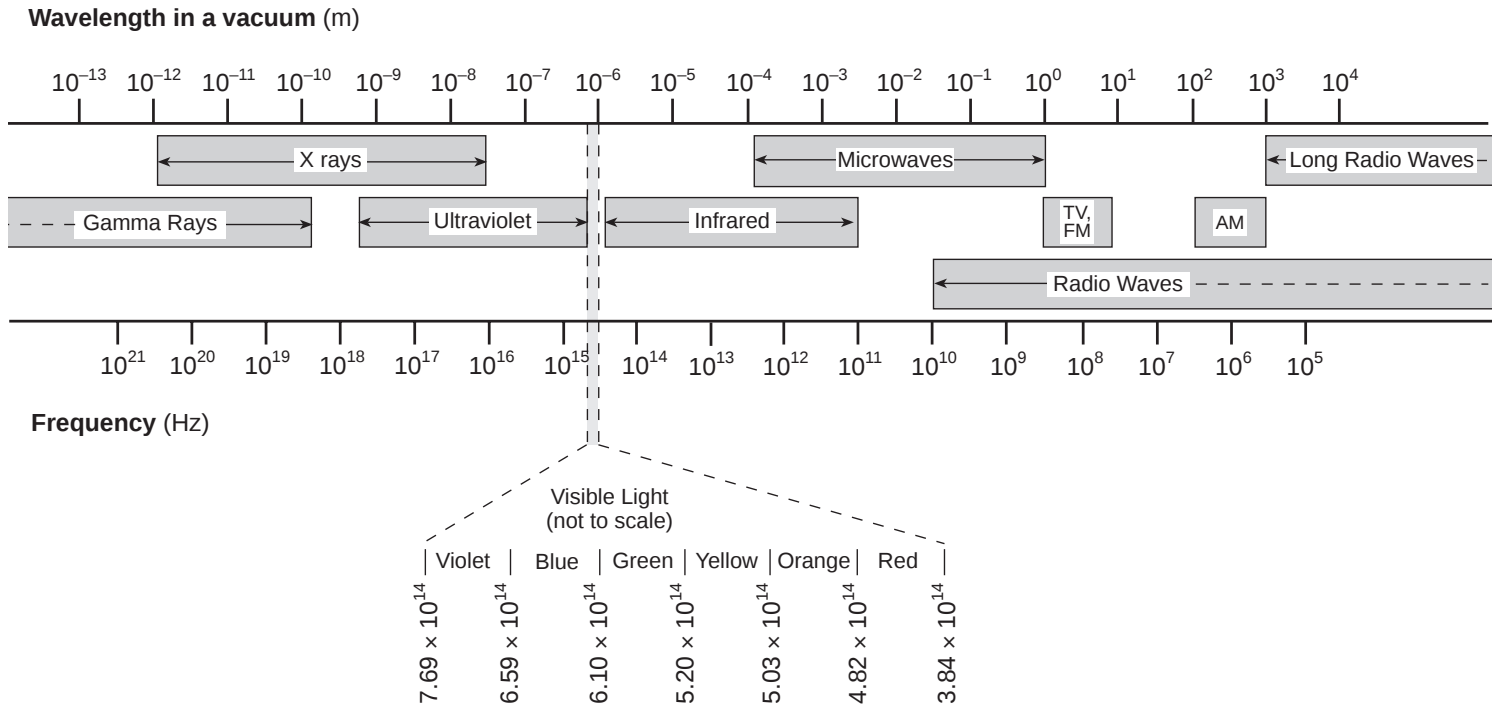
List of Physical Constants		
Name	Symbol	Value
Universal gravitational constant	G	$6.67 \times 10^{-11} \text{ N} \cdot \text{m}^2/\text{kg}^2$
Acceleration due to gravity	g	9.81 m/s^2
Speed of light in a vacuum	c	$3.00 \times 10^8 \text{ m/s}$
Speed of sound in air at STP		$3.31 \times 10^2 \text{ m/s}$
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	μ	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



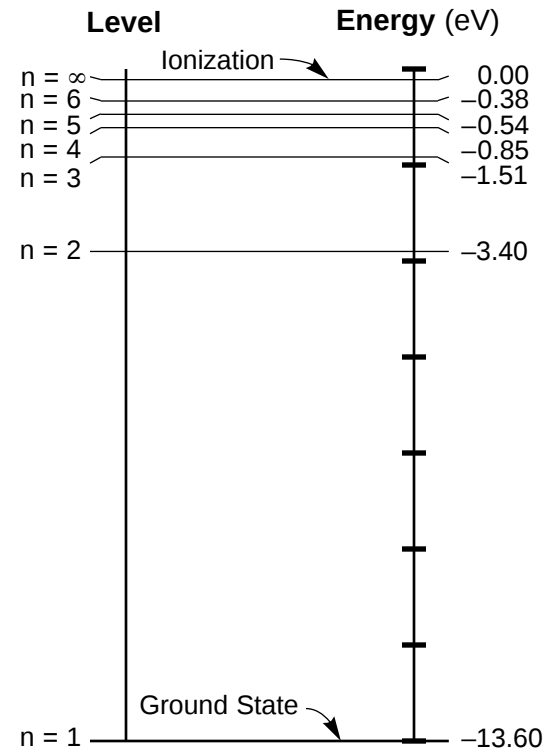
Absolute Indices of Refraction

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

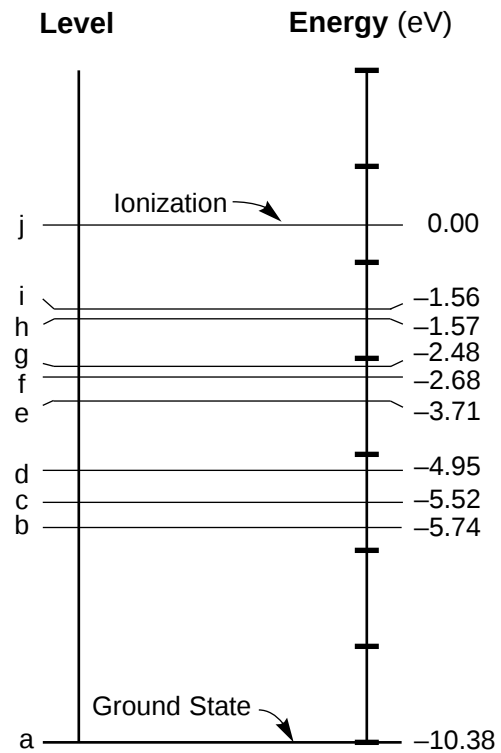
Energy Level Diagrams

Hydrogen



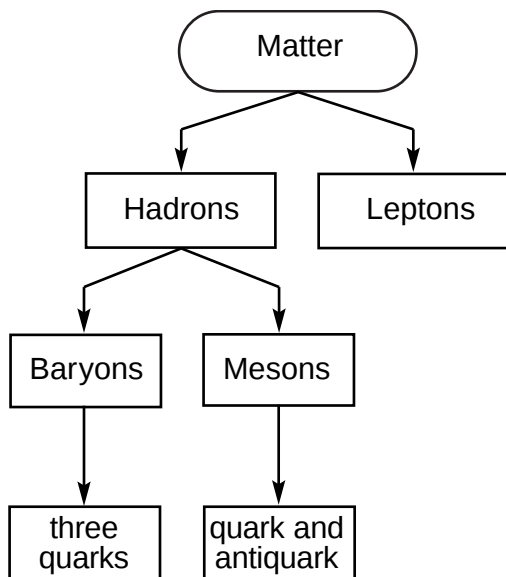
Energy Levels for the Hydrogen Atom

Mercury



A Few Energy Levels for the Mercury Atom

Classification of Matter



Particles of the Standard Model

Quarks

Name	up	charm	top
Symbol	u	c	t
Charge	$+\frac{2}{3}e$	$+\frac{2}{3}e$	$+\frac{2}{3}e$

down	strange	bottom
d	s	b
$-\frac{1}{3}e$	$-\frac{1}{3}e$	$-\frac{1}{3}e$

Leptons

electron	muon	tau
e	μ	τ
$-1e$	$-1e$	$-1e$

electron neutrino	muon neutrino	tau neutrino
ν_e	ν_μ	ν_τ
0	0	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)

Δ = change

ρ = 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 ($\Omega \cdot \text{m}$)
Aluminum	2.82×10^{-8}
Copper	1.72×10^{-8}
Gold	2.44×10^{-8}
Nichrome	$150. \times 10^{-8}$
Silver	1.59×10^{-8}
Tungsten	5.60×10^{-8}

Waves and Optics

$$v = f\lambda$$

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

$$\theta_i = \theta_r$$

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

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

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

c = speed of light in a vacuum

f = frequency

n = absolute index of refraction

T = period

v = velocity

λ = wavelength

θ = angle

θ_i = incident angle

θ_r = reflected angle

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

λ = wavelength

Geometry and Trigonometry

Rectangle

$$A = bh$$

A = area

b = base

Triangle

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

C = circumference

h = height

r = radius

Circle

$$A = \pi r^2$$

$$C = 2\pi r$$

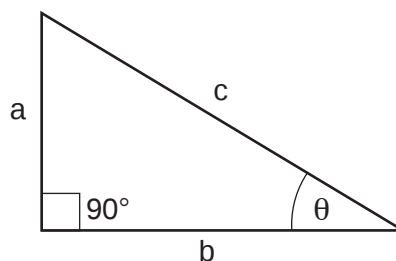
Right Triangle

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

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

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

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



Mechanics

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

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

$$v_f = v_i + at$$

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

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

$$A_y = A \sin \theta$$

$$A_x = A \cos \theta$$

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

$$F_f = \mu F_N$$

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

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

$$p = mv$$

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

$$J = Ft = \Delta p$$

$$F_s = kx$$

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

$$F_c = ma_c$$

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

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

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

$$W = Fd = \Delta E_T$$

$$E_T = PE + KE + Q$$

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

a = acceleration

a_c = centripetal acceleration

A = any vector quantity

d = displacement/distance

E_T = total energy

F = force

F_c = centripetal force

F_f = force of friction

F_g = weight/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/distance between centers

t = time interval

v = velocity/speed

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

W = work

x = change in spring length from the
equilibrium position

Δ = change

θ = angle

μ = coefficient of friction