Useful Information

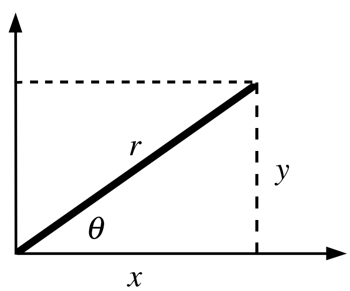
Prefixes

10^{24}	yotta (Y)	10^{-1}	deci (d)
10^{21}	zetta (Z)	10^{-2}	centi (c)
10^{18}	exa (E)	10^{-3}	milli (m)
10^{15}	peta (P)	10^{-6}	micro (μ)
10^{12}	tera (T)	10^{-9}	nano (n)
10^{9}	giga (G)	10^{-12}	pico (p)
10^{6}	mega (M)	10^{-15}	femto (f)
10^{3}	kilo (k)	10^{-18}	atto (a)
10^{2}	hecto (h)	10^{-21}	zepto (z)
10^{1}	deca (da)	10^{-24}	yocto (y)

English - Metric Conversion Factors

1 inch = 2.54 centimeters
1 foot = 30.48 centimeters
1 yard = 91.44 centimeters
1 mile = 5280 feet = 1609 meters
1 meter = 39.37 inches = 3.281 feet
1 pound = 4.448 newtons
1 horsepower = 745.7 watts
1 gallon = 3.785 liters
1 calorie = 4.187 joules
1 btu = 1055 joules

Trigonometry



$$\sin\theta = \frac{y}{r} \qquad \cos\theta = \frac{x}{r} \qquad \tan\theta = \frac{y}{x}$$

$$r = \sqrt{x^2 + y^2} \qquad \theta = \tan^{-1}\left(\frac{y}{x}\right)$$

Constants

mass of earth	M_e	5.97×10^{24} kg
mass of sun	M_s	1.99×10^{30} kg
mass of moon	M_m	7.36×10^{22} kg
radius of earth	R_e	6.37×10^{6} m
radius of moon	R_m	1.74×10^{6} m
radius of sun	R_s	6.96×10^{8} m
Earth-moon distance		3.84×10^{8} m
Earth-sun distance		1.496×10^{11} m
speed of light	c	3.0×10^{8} m/s
grav. constant	G	6.67×10^{-11} Nm²/kg²
Coulomb constant	k	9.0×10^{9} Nm²/C²
electron charge	e^-	-1.60×10^{-19} C
proton charge	e^+	$+1.60 \times 10^{-19}$ C
electron rest mass	m_e	9.11×10^{-31} kg
proton rest mass	m_p	1.673×10^{-27} kg
neutron rest mass	m_n	1.675×10^{-27} kg

International System of Units (Metric)

Base Units

Physical quantity	Name of Unit	Symbol
length	meter	m
mass	kilogram	kg
time	second	s
electric current	ampere	A
temperature	Kelvin	K
amount of substance	mole	mol
luminous intensity	candela	cd

International System of Units (Metric)

Derived Units

Physical quantity	Name of Unit	Symbol
frequency	hertz	Hz
energy	joule	J
force	newton	N
power	watt	W
electric charge	coulomb	C
electric potential	volt	V
electric resistance	ohm	Ω

Percent Error

Percent error is calculated to compare an experimental value to a known value.

$$\text{Percent Error} = \left|\frac{\text{Known - Experimental}}{\text{Known}}\right| \times 100\%$$

Percent Difference

Percent difference is calculated to compare two experimental values to each other.

$$\text{Percent Diff.} = \left|\frac{\text{Exp}_1 - \text{Exp}_2}{(\text{Exp}_1 + \text{Exp}_2)/2}\right| \times 100\%$$

First Semester Equations

OPTICS

f = focal length (cm or m)

d_o = object distance (cm or m)

d_i = image distance (cm or m)

h_o = object height (cm or m)

h_i = image height (cm or m)

M = magnification

n = index of refraction

c = speed of light in a vacuum (m/s)

v = speed of light in a substance (m/s)

θ_c = critical angle

$c = 3.0 \times 10^8$ m/s

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i} \qquad P\text{ (diop)} = \frac{1}{f(\text{m})}$$

$$M = -\frac{d_i}{d_o} = \frac{h_i}{h_o}$$

$$M_{\text{TOTAL}} = M_1 \times M_2$$

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

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

$$\sin\theta_c = \frac{n_2}{n_1} \quad (n_1 > n_2)$$

Sign Conventions

d_i real = positive

d_i virtual = negative

f converging = positive

f diverging = negative

M upright = positive

M inverted = negative

h_i upright = positive

h_i inverted = negative

WAVES

f = frequency (hertz, Hz)

f_o, f_s = observer, source frequency

T = period (s)

λ = wavelength (m)

v = wave speed (m/s)

v_o, v_s = observer, source speed

P = power (watt, W)

I = sound intensity (W/m^2)

r = distance (m)

β = sound level (decibel, dB)

n = harmonic number

L = length (m)

μ = linear density (kg/m)

F_T = tension (newton, N)

d = slit spacing (m)

a = slit width (m)

m = min/max order number

speed of sound = 345 m/s

EM wave speed, $c = 3 \times 10^8$ m/s

$$f = \frac{1}{T} \qquad v = \frac{\lambda}{T} \qquad v = \lambda f$$

$$f_o = f_s\left(\frac{v \pm v_o}{v \mp v_s}\right)$$

$$I = \frac{P}{4\pi r^2} \qquad f_{beat} = |f_1 - f_2|$$

$$\beta = 10\log\left(\frac{I}{I_0}\right) \text{ where } I_0 = 10^{-12}$$

strings:

$$f_n = \frac{nv}{2L},\ n = 1,2,3... \qquad \mu = \frac{m}{L} \qquad v = \sqrt{\frac{F_T}{\mu}}$$

open pipes:

$$f_n = \frac{nv}{2L},\ n = 1,2,3...$$

closed pipes:

$$f_n = \frac{nv}{4L},\ n = 1,3,5...$$

interference maxima:

$$d\sin\theta = m\lambda \quad (m = 0,1,2,3,...)$$

interference minima:

$$d\sin\theta = (m + \tfrac{1}{2})\lambda \quad (m = 0,1,2,3,...)$$

single slit minima:

$$a\sin\theta = m\lambda \quad (m = 1,2,3,...)$$

ELECTRICITY

F_e = electric force (newton, N)

q = charge (coulomb, C)

E = electric field (N/C)

PE = potential energy (joule, J)

P = power (watt, W)

t = time (second, s)

ΔV = potential difference or voltage (volt, V)

I = current (amp, A)

R = resistance (ohm, Ω)

r, d = distance (m)

$k = 9.0 \times 10^9$ Nm^2/C^2

$e = 1.6 \times 10^{-19}$ C

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

$$E = \frac{F_e}{q_0}$$

$$\Delta V = \frac{\Delta PE}{q}$$

$$E = \frac{kq}{r^2} \quad \text{(point charge)}$$

$$\Delta V = Ed \quad \text{(constant } E \text{ field)}$$

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

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

$$P = \frac{\Delta PE}{t}$$

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

cost (\$) = rate$\left(\frac{\$}{\text{kWh}}\right)$ × energy(kWh)

series:

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

$$I = I_1 = I_2 = I_3$$

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

parallel:

$$\Delta V = \Delta V_1 = \Delta V_2 = \Delta V_3$$

$$I = I_1 + I_2 + I_3$$

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

Second Semester Equations

Kinematics

s_{avg} = average speed (m/s)

v_{avg} = average velocity (m/s)

a_{avg} = ave. acceleration (m/s^2)

t = time (s)

d = distance (m)

$\Delta x, \Delta y$ = displacement (m)

a = inst. acceleration (m/s^2)

v_i = initial velocity (m/s)

v_f = final velocity (m/s)

$s_{avg} = \frac{d}{t} \quad v_{avg} = \frac{\Delta x}{t} \quad a_{avg} = \frac{\Delta v}{t}$

$v_f = v_i + at$

$$\left.\begin{array}{l}\Delta x = v_i t + \frac{1}{2}at^2 \\ v_f^2 = v_i^2 + 2a\Delta x \\ \Delta x = \frac{1}{2}(v_i + v_f)t\end{array}\right\} \text{ OR } \Delta y$$

Projectile motion

t = time

Δx = horiz. displacement

Δy = vert. displacement

g = acceleration of gravity

v = velocity

v_x = horizontal velocity

v_{yi} = initial vertical velocity

v_{yf} = final vertical velocity

Components/Resultant:

$v_x = v\cos\theta \quad v = \sqrt{v_x^2 + v_y^2}$

$v_y = v\sin\theta \quad \theta = \tan^{-1}(v_y / v_x)$

Horizontal motion ($a_x = 0$)

$\Delta x = v_x t$

Vertical motion ($g = -9.8 \ \frac{m}{s^2}$)

$v_{yf} = v_{yi} + gt$

$\Delta y = v_{yi}t + \frac{1}{2}gt^2$

$v_{yf}^2 = v_{yi}^2 + 2g\Delta y$

$\Delta y = \frac{1}{2}(v_{yi} + v_{yf})t$

Dynamics

ΣF = resultant (net) force (N)

m, M = mass (kg)

F_g = force of gravity (weight) (N)

$g = 9.8 \ \frac{N}{kg}$ = grav. field strength

k = spring constant (N/m)

F_n = normal force (N)

F_r = air resistance (drag) (N)

F_s = static friction force (N)

F_k = kinetic friction force (N)

μ_s = coefficient of static friction

μ_k = coefficient of kinetic friction

F_T = tension (N)

F_{sp} = spring force (N)

$\Sigma \vec{F} = 0$ (1st Law)

$\Sigma \vec{F} = m\vec{a}$ (2nd Law)

$\vec{F}_{1,2} = -\vec{F}_{2,1}$ (3rd Law)

$F_g = mg \qquad F_{sp} = k\Delta x$

$F_s = \mu_s F_n \qquad F_k = \mu_k F_n$

Circular Motion & Gravitation

a_c = centripetal acceleration

F_c = centripetal force

F_g = gravitational force

v_t = tangential speed

T = period

r, R = distance, orbital radius

$a_c = \frac{v_t^2}{r} = \frac{4\pi^2 r}{T^2}$

$v_t = \frac{2\pi r}{T}$

$F_c = \frac{mv_t^2}{r} = \frac{4\pi^2 mr}{T^2}$

$F_g = \frac{Gm_1m_2}{r^2} \qquad T^2 = \frac{4\pi^2 R^3}{GM}$

Torque

$\tau = Fr\sin\theta = F_\perp r = r_\perp F$

$\Sigma\tau = 0$ (equilibrium)

Energy and Momentum

W = work (J)

d = displacement (m)

t = time (s)

P = power (W)

KE = kinetic energy (J)

GPE = grav. potential energy (J)

EPE = elastic potential energy (J)

TE = thermal energy (heat) (J)

F_k = kinetic friction force (N)

I = impulse ($N \cdot s$)

p = momentum ($kg \cdot m/s$)

$W = Fd\cos\theta$

$P = \frac{W}{t} = Fv$

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

$GPE = mgh$

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

$TE = F_k d$

$W + KE_i + PE_i = KE_f + PE_f + TE$

$I = Ft$

$Ft = m\Delta v$

$p = mv$

$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$

Relativity

γ = Lorentz factor

v = relative velocity

c = speed of light

t_0 = proper time

t = dilated time

L_0 = proper length

L = contracted length

$\gamma = 1 / \sqrt{1 - \frac{v^2}{c^2}}$

$t = \gamma \ t_0 \qquad L = \frac{L_0}{\gamma} \qquad p = \gamma mv$

$E = \gamma mc^2 \qquad KE = (\gamma - 1)mc^2$