PHYS1189-1199

DATA SHEET

Mechanics

Motion with constant acceleration: $v = v_o + at$

$$\Delta x = v_o t + \frac{1}{2} at^2$$

$$v^2 = v_o^2 + 2a\,\Delta x$$

Forces: $F = Gmm'/r^2$

$f_s\,(max) = \mu_s N$

$f_k = \mu_k N$

Torque: $\tau = rF \sin\theta$

$\tau = \mathbf{r} \times \mathbf{F}$

Centre of gravity: $X = \dfrac{x_1 w_1 + x_2 w_2 + \ldots}{w_1 + w_2 + \ldots}$

Circular motion: $a_r = v^2/r$

$v = r\omega$

$I = \sum mr^2 = \tau/\alpha$

Gravitational potential energy: $U = mgh$

Fluid Mechanics, Viscosity

Conservation of energy: $P + \rho g y + \frac{1}{2}\rho v^2 = \text{constant}$

Conservation of mass: $Q = \rho A\bar{v} = \text{constant}$

Viscosity: $F/A = \eta(\Delta v/\Delta y)$

Laminar flow in a pipe: $Q = \dfrac{\pi}{8\eta}\left(\dfrac{\Delta P}{l}\right) r^4 = \dfrac{\Delta P}{R_f}$

Alternating Electric Currents

Alternating current: $i(t) = I_m \sin(\omega t + \alpha)$

rms value: $I_{rms} = I_m/\sqrt{2}$

Resistance: $v_R = R\,i$

Inductance: $v_L = L\,di/dt$

Capacitance: $v_C = (1/C)q$

Reactance (series): $X = X_L - X_C = \omega L - \dfrac{1}{\omega C}$

Impedance: $Z = (\text{p.d. across})/(\text{current})$

Series impedance: $Z = (R^2 + X^2)^{1/2}$

Average power: $P = \frac{1}{2} I_m^2 R = I_{rms}^2 R$

$= E_{rms} I_{rms} \cos\Phi$

Series resonance: $\omega_o = (LC)^{-1/2}$

Ideal transformer: $V_2/V_1 = I_1/I_2 = N_2/N_1$

$Z_{eq} = (N_1/N_2)^2 R$

Photons, Atomic Physics

Photon energy: $E = hf$

Hydrogen energy levels: $E_n = -E_o/n^2$

de Broglie wavelength: $\lambda = h/p$

Nuclear Physics, Ionizing Radiation

Radioactive decay: $N/N_o = e^{-\lambda t} = (\frac{1}{2})^{t/T}$

Half life: $T = (\ln 2)/\lambda$

Binding energy $= c^2 \times (\text{mass defect})$

Activity: $A = \lambda n\, N_A$

Electricity

Electric forces and fields: $F = kq_1q_2/r^2$ (point charges)

$$k = \frac{1}{4\pi\varepsilon_o}$$

$F = qE$

Electric potential: $\Delta W = q\,\Delta V$

$V = kQ/r$ (point charge)

Capacitance: $C = Q/V$

$C = \dfrac{A}{4\pi kl} = \varepsilon_o A/l$ (parallel plates)

$C = K\varepsilon_o\, A/l$

$U = \frac{1}{2} QV$

Vectors

$\mathbf{A} + \mathbf{B} = \mathbf{B} + \mathbf{A}$

$\mathbf{A} \times \mathbf{B} = (AB \sin\theta)\hat{c}$

$\mathbf{A} \bullet \mathbf{B} = AB \cos\theta$

Nerve conduction:

$R = \rho_a \, l/\pi r^2$ (axoplasm resistance)
$C = C_m(2\pi rl)$ (membrane capacitance)
$G = G_m \, 2\pi rl$ (leakage conductance)
$\lambda = (R_m r/2\rho_a)^{1/2}$ (space parameter)

$$\ln \frac{c_1}{c_2} = -\frac{E_2-E_1}{k_B T} = -\frac{q(V_2-V_1)}{k_B T}$$

(Boltzmann dist. and Nernst eqn.)

$\Delta V_x = \Delta V_o \, e^{-x/\lambda}$ (weak stimulus)
$v \cong r/\rho_a \, C_m x$ (action potential)

Magnetic forces and fields:

$\mathbf{F} = q\mathbf{v}\times\mathbf{B}$ (moving charge)
$\mathbf{F} = I\mathbf{l}\times\mathbf{B}$ (electric current)
$B = 2\pi k'I/a = \mu_o I/2a$ (centre of circular loop)
$B = 4\pi k'In = \mu_o In$ (long solenoid)
$B = 2k'I/r = \mu_o I/2\pi r$ (long straight wire)
$F/\Delta l = 2k'II'/d = \mu_o II'/2\pi d$ (parallel conductors)

Induced currents and fields:

$\phi = BA \cos\theta$
$\varepsilon = -\Delta\phi/\Delta t$
$\varepsilon = -L \, di/dt$ (inductance)

$$U = \frac{1}{2} Li^2$$

Electric current: $I = enAv$
$R = V/I$
$\rho = RA/l = 1/\sigma$
$P = IV$

RC circuit transients: $i = i_o e^{-t/T}$
$q = q_o(1-e^{-t/T})$
$T = RC$

LR circuit transients: $i = i_o e^{-t/T_L}$
$i = i_o(1-e^{-t/T_L})$
$T_L = L/R$

Numerical Value of Constants

Speed of light (in vac.)	c	$= 3.00\times10^{8}$ ms^{-1}
Atomic mass unit	u	$= 1.66\times10^{-27}$ kg
Electron mass	m_e	$= 9.11\times10^{-31}$ kg
Proton mass	m_p	$= 1.673\times10^{-27}$ kg
Neutron mass	m_n	$= 1.675\times10^{-27}$ kg
Planck's constant	h	$= 6.63\times10^{-34}$ Js
		$= 4.14\times10^{-15}$ eVs
Acceleration of gravity	g	$= 9.80$ ms^{-2}
Gravitational constant	G	$= 6.67\times10^{-11}$ Nm^2 kg^{-2}
Boltzmann constant	k_B	$= 1.38\times10^{-23}$ JK^{-1}
Electron charge	-e	$= 1.60\times10^{-19}$ C

Coulomb constant, $k = \frac{1}{4\pi\varepsilon_o} = 9.00\times10^{9}$ Nm^2 C^{-2}
Permittivity constant, $\varepsilon_o = 8.85\times10^{-12}$ Fm^{-1}
Biot-Savart constant, k' $= 10^{-7}$ TmA^{-1}
Permeability constant, $\mu_o = 1.26\times10^{-6}$ Hm^{-1}