Chapter 2: Motion along A Straight Line

s = speed	t = time
Total Distance	$x_f + x_i$
One Dimensional Motion	
Distance	d = s·t
Displacement	$x_f - x_i$
Speed	$(x_f + x_i) / (t_f + t_i`)$
Not Constant Velocity	
Average Velocity	$(x_f - x_i) / (t_f - t_i`)$
x↑: v+ x↓: v- x→: v=0	a+: v↑ a-: v↓ a=0: v→
Instantaneous Acceleration	
$(v_f - v_i) / (t_f - t_i`)$	
Constant Acceleration in 1D	
$V_f = V_i + (a \cdot t)$	
Constant Acceleration Final Distance	
$X_f = 1/2(V_f - V_i) \cdot t$	
$X_f = X_i + (V_i \cdot t) + 1/2(a \cdot t)$	
$a = (V_f - V_i) / t$	$t = (V_f - V_i) / a$
$V_f = V_i \cdot a^2$	
$V_f^2 = V_i^2 + 2 \cdot a (x_f - x_i)$	
G_y = -9.8 m/s	

Chapter 14: Periodic Motion

Angular Frequency	w = 2πf 2π/T
Frequency	f = 1 / T
Period	T = 1 / f
Restoring Force	F_x = -kx
Simple Harmonic Motion	
k = Spring Constant	x = displacement
m = mass	

Chapter 14: Periodic Motion (cont)

Displacement as function of time	x = Acos(wt + Θ)
Velocity as function of time	v = -wAsin(wt + Θ)
Acceleration as function of time	$a = -w^2$Acos(wt + Θ)
xmax = A [Amplitude]	**-xmax** = A [Amplitude]
vmax = wA	**-vmax** = wA
amax = w^2A	**-amax** = w^2A
Equation for Simple Harmonic Motion	a`x = - (k/m) x
k = restoring force	
Angular Frequency for SHM	w = √k/m
Frequency for SHM	f = w/2π
	f = 1/2π√k/m
Period for SHM	T = 1/f
	T = 2π/w
	T = 2π√m/k
Total Mechanical Energy (Constant)	$E = 1/2mv_x^2 + 1/2kx^2$
	$E = 1/2kA^2$

Chapter 6: Work and Kinetic Energy

1km = 1000m	1 kg = 1000g
Dot Product	P = Power
$A \cdot B = (A_i \cdot B_i)+(A_j \cdot B_j)$	t = s
Work = Force · distance	
W = F_x· distance	
W = F·cosΘ·distance	
K_E: $1/2 \cdot m \cdot v^2$	U = m·g·h

Chapter 6: Work and Kinetic Energy (cont)

$W_{total} = K_{Ef} - K_{Ei}$	
W_x = F (cosΘ)·s || W_y = F (sinΘ)·s	
Constant Speed	
Friction (opposite) = cos(180^o)	
P = F·v	P = (W/t)
P_{av}= ΔW / Δt [Average Power]	if F→ & s← = - W
if F↓ & s→ = 0	if F→ & s→ = W
Force Required to Stretch a spring	
F_x = k · x	

Chapter 13: Newton's Law of Gravitation

$G_E = 6.67 \cdot 10^{-11}$	Earth Gravity Constant
$R_E = 6.38 \cdot 10^6$ m	Earth Radius
$M_E = 5.972 \cdot 10^{24}$ kg	Mass of Earth
g = 9.8 m/s; a_g = 9.8 m/s	$r - R_E = h$
$F_g = (G_E \cdot m_1 \cdot m_2) / (r^2)$	$F_g = m \cdot a$
w = m·g	$s = r - R_E$ cosΘ
Gravitation and Spherically Symmetric Bodies	$F_g = (G_E \cdot m_E \cdot m) / (r^2)$
Weight of the body at Earth's Surface	$w = F_g = (G_E \cdot m_E \cdot m) / (R_E^2)$
Acceleration due to Gravity	$g = (G_E \cdot m_E) / (R_E^2)$
Velocity of Earth	$V_E = 4/3\pi R_E^2 = 1.08 \cdot 10^{21}$ m^3
Gravitational Potential Energy	
$U = -(G_E \cdot m_E \cdot m) / (r)$	

Chapter 13: Newton's Law of Gravitation (cont)

WorkDone by Gravity	$W_{grav} = m \cdot g(r_1 - r_2)$
$W_{grav} = Gm_E \cdot m \cdot (r_1 - r_2) / (r_1 \cdot r_2)$	
$W_{grav} = Gm_E \cdot m \cdot (r_1 - r_2) / (R_E^2)$	[if the body stays close to Earth]
Speed of the Satellite	$v = \sqrt{(G \cdot m_E / r)}$
Period of Circular Orbit	$T = (2\pi r / v)$
$T = 2\pi r^{3/2} / \sqrt{G \cdot m_E}$	$T = 2\pi r \sqrt{(r / G \cdot m_E)}$
Point Mass Outside a Spherical Shell	$U_i = - Gm \cdot m_i / s$
Apparent weight ; Earth's Rotation	
w_0 = true weight of object	F = force exerted by spring scale
F + w_0 = net force on object	w = apparent weight = opposite of F
centripetal acceleration`	$w_0 - F = (mv^2 / R_E)$
	$w = w_0 - (mv^2 / R_E)$
freefall acceleration	$g = g_0 - (v^2 / R_E)$
Black Holes	
P = Density	P = M / v
$v = 4/3 \pi R^3$	c = speed of light in the vaccum
Schwardzschild Radius	$R_s = 2GM / c^2$
$c = \sqrt{2GM / R_S}$	

Chapter 7: Potential Energy, Energy Conservation

Y-axis E = Mechanical Energy
$W_{grav} = F \cdot s = w(y_1 - y_2)$
$W_{grav} = (m \cdot g \cdot y_1) - (m \cdot g \cdot y_1)$
$W_{grav} = U_{grav,1} - U_{grav,2}$
$W_{grav} = -\Delta U_{grav}$
Conservation of Mechanical Energy
$K_f - K_i = U_{grav,1} - U_{grav,2}$
$K_i + U_{grav,1} = K_f + U_{grav,2}$
$E = K + U_{grav}$ = constant (if gravity does work)
When other forces than Gravity do work
$W_{other} + W_{grav} = K_f - K_i$
Elastic Potential Energy
$U_{el} = 1/2kx^2$
Work Done a Spring
$W = 1/2kx_2^2 - 1/2kx_1^2$
If Elastic does work, total mechanical energy is stored
$K_i + U_{el,1} = K_f + U_{el,2}$
Situations with Both Gravitational and Elastic Potential Energy
$K_1 + U_1 + W_{other} = K_2 + U_2$
The work done by all forces other than the gravitational force or elastic force equals the change in total mechanical energy E = K + U of the system
The Law of Conservation of Energy
$\Delta U_{int} = -W_{other}$ ΔU_{int} = internal energy
Force and Potential Energy
$F_x(x) = - dU(x) / dx$

Chapter 14: Periodic Motion (cont.)

The Simple Pendelum (TSP)	L = pendulum length
Angular Frequency TSP	$w = \sqrt{k/m}$
	$w = \sqrt{mg / L} / m$
	$w = \sqrt{g/L}$
Frequency TSP	$f = w/2\pi$
	$f = 1/2\pi \sqrt{g/L}$
Period TSP	$T = 2\pi/w$
	$T = 1/f$
	$T = 2\pi\sqrt{L/g}$
The Physical Pendulum (TPP)	
L = angular momentum	L = mvr
w = Angular Velocity	$w = \Delta\Theta / \Delta t$
(I)nertia = L / w	
Angular Frequency TPP	$w = \sqrt{mgd / I}$
Period TPP	$T = 2\pi \sqrt{I / mgd}$
Damped Oscillation	
b = Damping Constant	
Displace of Damped	$x = Ae^{-b(2m)t}$ cost $(wt + \Theta)$
Angular Frequency of Damped	$w' = \sqrt{(k/m) - (b^2 / 4m^2)}$
Force Oscillations and Resonance	
F_{max} = Maximum Driving Force	k = constant restoring force
w_d = Driving Angular Frequency	
$A = F_{max} / \sqrt{(k - mw_d^2)^2 + b^2 w_d^2}$	