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	
$V_f = V_i + (a·t)$	
Constant Acceleration Final Distance	
$X_f= 1/2(V_f-V_i) \cdot t$	
$X_f= X_i + (V_i\cdot t) + 1/2(a \cdot t)$	
$a = (V_f-V_i) / t$	$t = (V_f-V_i) / a$
$V_f = V_i \cdot a^2$	
$V_f^2 = V_i^2 + 2·a (x_f-x_i)$	
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	$a = -w^2Acos(wt + Θ)$
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
$A·B = (A_i·B_i)+(A_j·B_j)$	t = s
Work = Force · distance	
$W = F_x\cdot$ distance	
W = F·cosΘ·distance	
$K_E: 1/2·m·v^2$	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	
$F_x = k \cdot x$	

Chapter 13: Newton's Law of Gravitation

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

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

WorkDone by Gravity	W_{grav} = m·g(r_1-r_2)
W_{grav} = Gm_E·m · (r_1-r_2) / (r_1·r_2)	
W_{grav}= Gm_E·m · (r_1-r_2) / (R_E^2)	[if the body stays close to Earth]
Speed of the Satellite	v = √(G·m_E / r)
Period of Circular Orbit	T = (2πr / v)
T = 2π$r^{3/2}$/√G·m_E	T = 2πr √(r / G·m_E)
Point Mass Outside a Spherical Shell	U_i = - Gm·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 = 4/3πR^3	c = speed of light in the vaccum
Schwardzschild Radius	R_S = 2GM / c^2
c = √2GM / R_S	

Chapter 7: Potential Energy, Energy Conservation

Y-axis
E = Mechanical Energy

W_{grav} = F · s = w(y_1-y_2)

W_{grav}=(m·g·y_1)-(m·g·y_1)

W_{grav}=$U_{grav,1}$ - $U_{grav,2}$

W_{grav} = -Δ 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

ΔU_{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 = √k/m
	w = √mg / L /m
	w = √g/L
Frequency TSP	f = w/2π
	f = 1/2π √g/L
Period TSP	T = 2π/w
	T = 1/f
	T = 2π√L/g
The Physical Pendulum (TPP)	
L = angular momentum	L = mvr
w = Angular Velocity	w = ΔΘ / Δt
(I)nertia = L / w	
Angular Frequency TPP	w = √mgd / I
Period TPP	T = 2π √ I / mgd
Damped Oscillation	
b = Damping Constant	
Displace of Damped	x = $Ae^{-b(2m)t}$ cost (wt + Θ)
Angular Frequency of Damped	w' = √ (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} / √(k-mw_d^2)^2 + $b^2w_d^2$	