

Chapter 1 Unit(s) / Mechanics / Sig-Figs / Vectors
Speed = (d/t) (m/s) d = distance : m = meters t = time : s = seconds
1 km = 1000 m
1 kg = 1000 g mass = (kg)
1 hour = 3600 seconds time = (seconds)
1 mile = 1.609 km length = (meter)
Volume = 1 cm ³
Sig Figs
$\pi = 3.14$ (3 sigfig)
$\pi = 3.14159$ (6 sigfig)
Density = (mass / volume) (kg / m ³) (g / cm ³)
$\sqrt{\quad}$ = square root
Vector (Displacement) = $\sqrt{(x)^2 + (y)^2}$
Total distance = x + y
Vector A = Vector B if Vector A = Vector B
Magnitude: $\sqrt{(x)^2 + (y)^2}$ = (Answer in Units) : 1 Direction
Components of Vector
Vector A = Ax + Ay Ax = A · cos(Θ) Ay = A · sin(Θ)
A = $\sqrt{(A \cdot \cos(\Theta))^2 + (A \cdot \sin(\Theta))^2}$
Θ = Angle
x = cos(Θ) cos(Θ) = Ax / A y = sin(Θ) sin(Θ) = Ay / A

Chapter 1 Unit(s) / Mechanics / Sig-Figs / Vectors (cont)
tan(Θ) = (y / x) or (Ay / Ax) or (By / Bx)
x = î Vector A = Axî + Ayĵ y = ĵ Vector B = Bxî + Byĵ z = k̂
Vector R = Vector A + Vector B Vector R = (Ax + Bx)î + (Ay + By)ĵ Vector R (direction) = (x)î + (y)ĵ Vector R (magnitude) = $\sqrt{(x)^2 + (y)^2}$
Quadratic Formula
$x = (-b \pm \sqrt{b^2 - 4 \cdot a \cdot c}) / (2 \cdot a)$
Chapter 2: Motion along A Straight Line
One Dimensional Motion
Average Speed = (total distance) / (time)
Displacement = Final Point - Initial Point
Not Constant Velocity
Average Velocity (V) = (displacement / time)
Average Velocity (V) = (Δx / Δt)
Instantaneous Velocity = derivative of the given equation
Instantaneous Velocity = ((a-final) - (a-initial)) / ((t-final) - (t-initial))
Δt = (t-final) - (t-initial)
Δx = (x-final) - (x-initial)
Acceleration
ΔV = (V-final) - (V-initial)
Δt = (t-final) - (t-initial)

Chapter 2: Motion along A Straight Line (cont)
Acceleration (a) = (ΔV) / (Δt) [a is constant] if a > 0 (positive) if a < 0 (negative)
Instantaneous Acceleration = derivative of the given equation
Constant Acceleration = constant acceleration motion in 1D
V-final = (a · t) + V-initial $V\text{-final}^2 = (v\text{-initial})^2 + 2 \cdot a \cdot (t\text{-final} - (t\text{-initial}))$
Δx = (x-final) - (x-initial)
Δx = (v-average) · (seconds)
Δx = (1/2 · (V-final) + (V-initial)) · t (seconds)
x-final = 1/2 · ((V-initial) + (V-final)) · t + (x-initial)
x-final = x-initial + (V-initial) · t (seconds) + 1/2 · a · t ²
Gravity (g) = -9.8 m/s ²
V-final = (V-initial) + g · t (seconds)
Chapter 3: 2D or 3D Motion
The Acceleration Vector
a = ΔV / Δt (v-final) = (v-initial) + ΔV ΔV = (v-final) - (v-initial) ΔV = (v-final) + (-v-initial)
Constant Speed Changing Direction
a = ΔV / Δt (v-final) = (v-initial) + ΔV ΔV = (v-final) - (v-initial)

Chapter 3: 2D or 3D Motion (cont)
Projectile Motion two assumptions: 1. The freefall acceleration (g) is constant 2. Air resistance is negligible
y-direction = constant acceleration motion x-direction = constant velocity motion
Acceleration is only negative (y-direction) g = -9.8 m/s ²
Constant Velocity Motion
x = (x-initial) + (v [x-direction]) · t V (y-direction) = (v-initial) [y-direction] + g · t (y-final) = (y-initial + (v-initial) [y-direction]) · t + 1/2 · g · t ² V (y-direction) ² = (v-initial) [y-direction] ² + 2 · g · ((y-final) - (y-initial)) V (y-direction) = (v-initial) [y-direction] + g · t
Trig Identity
sin(ΘΘ) = sinΘcosΘ + cosΘsinΘ
Constant Speed Motion
<i>velocity is always changing</i> r = radius V = (2πr) ² : 4π ² r T = time-period a = ΔV / Δt : never zero ΔV = (V / r) · Δr
Centripetal Acceleration
Ac = (V ²) / r Ac = (2πr) ² / T ² Ac = 4π ² r / T ²
Tangential and Radial Acceleration
Ac = a-rad



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Chapter 3: 2D or 3D Motion (cont)

Vector A-total = Vector A-tangential + Vector A-radical
 $A_{\text{total}} = \sqrt{(A_{\text{tan}})^2 + (A_{\text{rad}})^2}$

Relative Motion

$r' = (v_{\text{initial}} \cdot t) - (\text{vector-r})$

Vector-r = $\sqrt{(v_{\text{initial}} \cdot t)^2 + (r')^2}$

Vector-V' = $(v_{\text{final}}) - (v_{\text{initial}})$

Chapter 4: Newtons Laws

Superposition of Forces

Vector-R = Vector-F1 + Vector-F2

N = Net Force

$F_x = N \cdot \cos(\theta)$

$R_x = \sum F_x$

$F_y = N \cdot \sin(\theta)$

$R = \sqrt{(R_x)^2 + (R_y)^2}$

Newton's 1st Law

No Force; No Acceleration; No Motion

Inertia:

the tendency of an object to resist any attempt to change its velocity

Newton's 2nd Law

Net Force = a (x-direction) = $F_x \text{ total} / \text{mass}$

a (y-direction) = $F_y \text{ total} / \text{mass}$

$\tan(\theta) = y / x$

Newton's 3rd Law

F_n = Normal Force

$F_y = F_n - m \cdot g \cdot \cos(\theta)$ $F_x = m \cdot g \cdot \sin(\theta)$

Chapter 5: Applying Newton's Laws

vector-F = $F_x = m \cdot a_x$

$m \cdot a$

T = tension $F_y = m \cdot a_y$

: friction

$y = T - m \cdot g$ $F_r = F_n$: Normal Force (F_n)

No Friction α = Coefficient

$F_n = m \cdot g$ $F_x = T_1 \cdot \cos(\theta) + T_2 \cdot \cos(\theta)$

$F_y = T_1 \cdot \sin(\theta) + T_2 \cdot \sin(\theta)$

Friction

Static Friction (f_s): Object not in motion

Kinetic Friction (f_k): Object is in motion

Empirical Formula

μ_k : Coefficient of

Kinetic Friction

μ_s : Coefficient of

Static Friction

Static: $f_s \leq \mu_s \cdot F_n$

F_n

Static: $f_k = \mu_k \cdot F_n$

F_n

Terminal Speed

$F_r \propto v$

Uniform Circular Motion

$F_r \propto v^2$

Uniform Circular Motion

$F_c = m \cdot a_c : m \cdot v^2 / r$

Chapter 5: Applying Newton's Laws (cont)

Vertical Top: $F_y = -m \cdot (v^2 / r)$

Circle

Bottom: $F_y = \mu_s \cdot m \cdot (g + v^2 / r)$

$\max V = \sqrt{(f_s \cdot r) / m}$

$\max V = \sqrt{\mu_s \cdot g \cdot r}$

Top

$T \cdot \sin(\theta) = m \cdot a_c$

View

$a_c = \tan(\theta) \cdot g$



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