

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 cm³

Sig Figs

$\pi = 3.14$ (3 sigfig)

$\pi = 3.14159$ (6 sigfig)

Density = (mass / volume) || (kg / m³) || (g / cm³)

$\sqrt{\quad}$ = 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 + Ayj
 y = ĵ Vector B = Bxî + Byj
 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 = $((a\text{-final}) - (a\text{-initial})) / ((t\text{-final}) - (t\text{-initial}))$

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) if a > 0 (positive)
 [a is constant] 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-final² = (v-initial)² + 2 · a (t-final) - (t-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 · t²

Gravity (g) = -9.8 m/s²

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

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/s²

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 · t²

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

velocity is always changing

r = radius V = (2πr)² : 4π²r

T = time-period

a = ΔV / Δt : never zero

ΔV = (V / r) · Δr

Centripetal Acceleration

Ac = (V²) / r

Ac = (2πr)² / r

Ac = 4π²r / T²

Tangential and Radial Acceleration

Ac = a-rad



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

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

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

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

Chapter 4: Newtons Laws

Superposition of Forces

Vector-R = Vector-F1 + Vector-F2

N = Net Force

$$F_x = N \cdot \cos(\theta) \quad R_x = \sum F_x$$

$$F_y = N \cdot \sin(\theta) \quad R_y = \sum F_y$$

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

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 = $m \cdot a$
 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

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

Chapter 5: Applying Newton's Laws

$$\text{vector-F} = m \cdot a \quad F_x = m \cdot a_x$$

T = tension
 : friction
 $F_y = m \cdot a_y$

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

No Friction α = Coefficient

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

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

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 $F_r \propto v$

$$F_r \propto v^2$$

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

Chapter 5: Applying Newton's Laws (cont)

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

$$\text{maxV} = \sqrt{(f_s \cdot r) / m}$$

$$\text{maxV} = \sqrt{\mu_s \cdot g \cdot r}$$

Top View
 $T \cdot \sin(\theta) = m \cdot a_c$
 $a_c = \tan(\theta) \cdot g$



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