Unit 1 → Kinematics

Measurements

- Scalar
  - Magnitude (size) only
- Vector
  - Magnitude AND direction

Adding Vectors

- Tail-to-tail
  - Parallelogram
- Head-to-tail
  - Complete the triangle
- R→resultant vector; sum of 2 or more vectors

Measuring Length

- Distance (scalar)
  - Length of path traveled
- Displacement (vector)
  - Straight line length from start to finish
- Fundamental unit
- Meters (m)

Speed and Velocity

- Speed (scalar)
  - Rate at which *distance* changes
- Velocity (vector)
  - Rate at which *displacement* changes
- Fundamental unit
  - Meters per second ($\frac{m}{s}$)
- Reference table: $\underline{v_x} = \frac{\Delta x}{t} = \frac{v_{x0}+v_x}{2}$
  - Δx→change in position (m)
  - v_{x0}→inital speed or velocity ($\frac{m}{s}$)
  - v_x→ final speed or velocity ($\frac{m}{s}$)
  - $\underline{v_x}$→ average speed or velocity ($\frac{m}{s}$)

Acceleration (vector)

- Rate at which *velocity* changes
- Fundamental unit
    - Meters per second per second; meters per second squared; $(\frac{m}{s^2})$
- Direction
    - Speeding up
        - Acceleration and motion in the *same* direction
    - Slowing down
        - Acceleration and motion in the *opposite* direction
- Reference table (some equations are simplified)
    - $v_x = v_{x0} + a_x t$
    - $\Delta x = v_{x0} t + \frac{1}{2} a_x t^2$
    - $v_x^2 = v_{x0}^2 + 2 a_x \Delta x$
    - $a_x \rightarrow$ acceleration in the x-direction

Free-Fall Motion

- Description of an objects motion when teh only unbalanced force acting on it is gravity

- CONFINED TO Y-AXIS ONLY
- Depnds on acceleration due to gravity (g)
- Does *not* depend on mass (m)
- Acceleration due to gravity
    - Varies planet to planet
        - Determined by planet
    - Same for ALL objects
    - Constant
- Time
    - Height determines time
    - Same height = same time
- Reference Table
    - Acceleration due to gravity $= g = -9.8\frac{m}{s^2}$
        - On Earth *ONLY*
        - Different planets have different g values
        - Always points down (-) towards center of the planet
- Key terms
    - Falls freely
    - Dropped
    - Released from rest
- Free-fall with v_{y0}
    - Key terms
        - Vertically/straight upward/downward
- Free-fall with v_i
    - At max height
        - Velocity = $0\,m/s$
    - Vertically when thrown up = velocity when it hits the ground
        - Only applied when starts and ends at same height
- Max height
    - Y-axis ONLY
        - $v_y = 0\,m/s$
        - $a_y = -9.8\,m/s^2$
        - $\Delta y =$ height
        - $v_y^2 = v_{y0}^2 + 2a_y\Delta y$

Graphing Motion

- Important information
    - Axies → tells you what information you're given
    - Slope → tells you how to break up your work
- Do individual slopes first; combine at the end

- Slope equation→$\frac{y_2-y_1}{x_2-x_1}=\frac{\Delta y}{\Delta x}$
- Area under a graph
    - Area = base × height = $x \times y$
    - Velocity vs. time
        - Area = Δx

Adding Vectors

- At 0°
    - a + b = c
- At 90°
    - $a^2+b^2=c^2$
    - $c=\sqrt{a^2+b^2}$
- At 180°
    - a + -b = c
- Resolution of vectors
    - $a_x+b_x=R_x$
    - $a_y+b_y=R_y$
    - $R_x^2+R_y^2=R^2$
- Steps
    - Add components
    - Find Resultants

Horizontal Projectile Motion

- Depends on…
    - Acceleration due to gravity (g)
    - Air resistance (ignore it)
- Does *not* depend on…
    - Mass (m)
- Acceleration

    - Y-axis
        - Determined by gravity of the planet
        - Same for all objects
        - Constant
    - X-axis
        - No jetpack, no air resistance
        - Constant a_x at $0\ m/s^2$
- Time
    - X and Y axis
        - Height determines time
        - Same in both axis (scalar)
    - Same objects have the same time
- Key terms
    - Thrown horizontally
    - Fired horizontally
    - ANYTHING horizontal;y
    - Range → horizontal displacement (Δx)

Angled Projectile Motion

- 45°
    - Greatest range
    - Longest horizontal displacement
- 30° or 60°
    - $45° \pm 15°$
    - Same range
- 15° or 75°

    - 45°$\pm$30°
    - Same range
- 90°
    - Greatest height
- Relationships
    - Greater angle, greater height, greater time
- Key terms
    - At an *angle* above or below the horizontal
- Max height
    - $v_y = 0\, m/s$
    - $a_y = -9.8\, m/s^2$
    - $\Delta y =$ height
    - $v_y^2 = v_{y0}^2 + 2a_y\Delta y$

1D Motion Quiz

Multiple Choice

1) A
2) C
3) B
4) BE
5) C
6) A
7) B
8) C
9) B
10) C

Short Response

11) *185.25* mi
12) *0* m/s
13) *2* m/s
14) *15* m/s
15) *2.5* m/s

1D Motion Test

Multiple Choice

1) C
2) A
3) D
4) A
5) C
6) A
7) B
8) B
9) C
10) B
11) A
12) B
13) C
14) A
15) B
16) B
17) D
18) D
19) B
20) C

Short Response

21) $410\,m$
22) $69.2\,m$
23) $-14\,m/s$
24) $180.41\,m$
25) $25.9\,m$

2D Motion Quiz

Multiple Choice

1) B
2) A
3) C
4) D
5) B
6) D
7) D
8) A
9) A
10) A

Short Response

11) $2m\ 60° N \circ E$
12) $16.38\,m$ @ 78°
13) $5.99\,m/s$
14) $206.16\,m/s\ 75.96° N \circ E$
15) $0.5\,m/s$

2D Motion Test

Multiple Choice

1) B
2) B
3) D
4) A
5) D
6) A
7) B
8) D
9) B
10) B
11) C
12) B
13) C
14) CE
15) D
16) A
17) A
18) C
19) A
20) D

Short Response

21) $21\,m/s$
22) $45.18\,m/s$
23) $0.287\,m$
24) $35.8\,m/s$
25) $35.3\,m$