

Formulas PHYS102, Common Exam 1, Spring 2023

Formulas for Motion in 1-dimension

$$\text{Displacement} = \Delta x = x_2 - x_1$$

$$\text{Average velocity } v_{avg} = \frac{x_2 - x_1}{t_2 - t_1}$$

$$\text{(Average speed)} = s_{avg} = \frac{\text{(Total distance)}}{\text{(Time change)}}$$

$$\text{Average acceleration } a_{avg} = \frac{v_2 - v_1}{t_2 - t_1}$$

$$\text{Motion with a constant velocity, } v \quad x = x_0 + v t$$

Motion with a constant acceleration "a"

$$v = v_0 + a t \quad x = x_0 + v_0 t + \frac{1}{2} a t^2$$

$$v^2 - v_0^2 = 2a(x - x_0) \quad x - x_0 = \frac{1}{2}(v_0 + v)t$$

Free fall motion:

Motion with a constant acceleration "-g",
where $g = 9.8 \text{ m/s}^2$ (+y direction points up)

$$v = v_0 - g t \quad y = y_0 + v_0 t - \frac{1}{2} g t^2$$

$$v^2 - v_0^2 = -2g(y - y_0)$$

Vector Components vs. magnitude and direction

$$\begin{cases} A_x = A \cos(\theta) & (\text{adjacent}) = (\text{hypotenuse}) \times \cos \theta \\ A_y = A \sin(\theta) & (\text{opposite}) = (\text{hypotenuse}) \times \sin \theta \end{cases}$$

$$\begin{cases} |\vec{A}| = \sqrt{(A_x)^2 + (A_y)^2} \\ \theta = \tan^{-1}\left(\frac{A_y}{A_x}\right) = \arctan\left(\frac{A_y}{A_x}\right) \\ \text{(add/subtract 180 deg if necessary)} \end{cases}$$

Equations for Projectile Motion

If the initial velocity $\vec{v}_0 = (v_{0x}, v_{0y})$

$$v_{0x} = v_0 \cos \theta_0$$

and the initial position $\vec{r}_0 = (x_0, y_0)$ are given, $v_{0y} = v_0 \sin \theta_0$

X-component (horizontal)
motion

Y-component (vertical) motion
(+y direction points up)

$$v_x = v_{0x}$$

$$v_y = v_{0y} - g t$$

$$x = x_0 + v_{0x} t$$

$$y = y_0 + v_{0y} t - \frac{1}{2} g t^2$$

$$\text{Range: } (v_0^2/g) * \sin(2\theta)$$

$$v_y^2 - v_{0y}^2 = -2g(y - y_0)$$

Units:

$$1 \text{ cm} = 10^{-2} \text{ m} \quad ; \quad 1 \text{ km} = 1000 \text{ m}$$

$$1 \text{ g} = 10^{-3} \text{ kg}$$

$$1 \text{ lt} = 1000 \text{ ml}; \quad 1000 \text{ lt} = 1 \text{ m}^3$$

$$\Delta y = \left(\frac{v_{0y} + v_y}{2} \right) \cdot t$$