Projectile Motion Video: 2 position time graphs

\[ X_f = X_0 + V_{0x} t + \frac{1}{2} a_x t^2 \]
Constant velocity in the x direction
NO Acceleration

\[ Y_f = Y_0 + V_{0y} t + \frac{1}{2} a_y t^2 \]
Do NOT have a constant velocity
Negative Acceleration
\[ |a| = |g| = 9.81 \text{ m/s}^2 \]
It appears that acceleration in the y direction, does not cause acceleration in the x direction.

\[ V_{ox} = 3 \text{ m/s} \quad a_x = 0 \]
\[ V_{oy} = 4 \text{ m/s} \quad a_y = -10 \text{ m/s}^2 \]

Remember: the acceleration (vector) tells us how much the velocity changes each second.

\[ -10 \text{ m/s}^2 \]

 CORE IDEA: 2D problems are really just two separate 1D problems
**Example:** Throw a rock off a 100m cliff with initial horizontal velocity of 5 m/s

1) How long does it take to hit the ground?
2) How far from the base of the cliff does it hit?

\[ V_x = 5 \text{ m/s} \]
\[ V_y = 0 \text{ m/s} \]
\[ a_x = 0 \]
\[ a_y = -10 \text{ m/s}^2 \]
\[ X_0 = 0 \text{ m} \]
\[ X_f = 100 \text{ m} \]
\[ Y_f = 0 \text{ m} \]

**Diagram:**
- Initial position at (0, 0)
- Final position at (100, 0)
- Vertical displacement is 0

**Equations:**
1. \[ Y_f = Y_0 + V_y t + \frac{1}{2} a_y t^2 \]
   \[ 0 = 0 + 0 + \frac{1}{2} (-10) t^2 \]
   \[ t = \sqrt{\frac{2(100)}{10}} = 4.55 \text{ s} \]

2. \[ X_f = X_0 + V_x t + \frac{1}{2} a_x t^2 \]
   \[ X_f = 5 \text{ m/s} \times 4.55 \text{ s} = 22.5 \text{ m} \]