## Projectile Motion Flow Chart



## Horizontally Launched Projectiles (Cliff Problem)

Projectiles which have NO upward trajectory and NO initial VERTICAL velocity.

$$
v_{y i}=0
$$



## Cliff Problem

Example: A plane traveling with a horizontal velocity of 100 $\mathrm{m} / \mathrm{s}$ is 500 m above the ground. At some point the pilot decides to drop some supplies to designated target below. (a) How long is the drop in the air? (b) How far away from point where it was launched will it land?

| What do I know? | What I want to <br> know? |
| :--- | :--- |
| $v_{\mathrm{x}}=100 \mathrm{~m} / \mathrm{s}$ | $\mathrm{t}=?$ |
| $\Delta \mathrm{y}=-500 \mathrm{~m}$ | $\Delta \mathrm{x}=?$ |
| $\mathrm{v}_{\mathrm{yi}}=0 \mathrm{~m} / \mathrm{s}$ |  |
| $\mathrm{a}=-10 \mathrm{~m} / \mathrm{s} / \mathrm{s}$ |  |

$$
\begin{aligned}
\Delta y & =\frac{1}{2} a t^{2} \\
t & =\sqrt{\frac{2 \Delta y}{a}}=\sqrt{\frac{2 x-100 \mathrm{~m}}{-10 \mathrm{~m} / \mathrm{s}^{2}}} \div 10 \mathrm{~s} \\
\Delta x & =v_{x} t \\
& =1000 \mathrm{~m} \quad 10.1 \text { seconds } \quad 1010 \mathrm{~m}
\end{aligned}
$$

## Golf Ball Problem

There is symmetry in the trajectory as the object rises and falls.


## Golf Ball Problem

A place kicker kicks a football with a velocity of $20.0 \mathrm{~m} / \mathrm{s}$ and at an angle of 53 degrees.
(a) How long is the ball in the air?
(b) How far away does it land?
(c) How high does it travel?


## Example

A place kicker kicks a football with a velocity of $20.0 \mathrm{~m} / \mathrm{s}$ and at an angle of 53 degrees.
(a) How long is the ball in the air?

| G | $U$ |
| :--- | :--- |
| $v_{x}=12.0 \mathrm{~m} / \mathrm{s}$ | $\mathrm{t}=?$ |
| $v_{\mathrm{yi}}=16.0 \mathrm{~m} / \mathrm{s}$ | $\Delta x=?$ |
| $\Delta y=0$ | $y_{\max }=?$ |
| $\mathrm{a}=-10 \mathrm{~m} / \mathrm{s} / \mathrm{s}$ |  |

$$
\mathrm{t}=3.2 \mathrm{~s}
$$

## Example

A place kicker kicks a football with a velocity of $20.0 \mathrm{~m} / \mathrm{s}$ and at an angle of 53 degrees.
(b) How far away does it land?

| $G$ | $U$ |
| :--- | :--- |
| $\mathrm{v}_{\mathrm{x}}=12.04 \mathrm{~m} / \mathrm{s}$ | $\mathrm{t}=3.26 \mathrm{~s}$ |
| $\mathrm{c}=15.97 \mathrm{~m} / \mathrm{s}$ | $\Delta x=?$ |
| $\Delta y=0$ | $y_{\text {max }}=?$ |
| $a=-10 \mathrm{~m} / \mathrm{s} / \mathrm{s}$ |  |

$\Delta x=v_{x} t$

## Example

A place kicker kicks a football with a velocity of $20.0 \mathrm{~m} / \mathrm{s}$ and at an angle of 53 degrees.
(c) How high does it travel?

| $G$ | $U$ |
| :--- | :--- |
| $v_{o x}=12.04 \mathrm{~m} / \mathrm{s}$ | $\mathrm{t}=3.26 \mathrm{~s}$ |
| $v_{o y}=15.97 \mathrm{~m} / \mathrm{s}$ | $x=39.24 \mathrm{~m}$ |
| $\Delta y=0$ | max h? <br> $\Delta y$ halfway $=?$ |
| $\mathrm{a}=-10 \mathrm{~m} / \mathrm{s} / \mathrm{s}$ |  |

CUT YOUR TIME IN HALF!

$$
\Delta y=v_{y_{i}} t+\frac{1}{2} a t^{2}=
$$

## Projectile Motion Flow Chart



## Cliff Problem

To analyze a projectile in 2 dimensions we need 2 equations. One for the " $x$ " direction and one for the " $y$ " direction. And for this we use kinematic \#2.


