Hunter and Bear:

Hunter shoots arrow at bear sitting on tree. As the arrow is released, bear falls vertically down. If the arrow was initially aimed at bear, will it hit bear?

\[
\frac{h}{x_T} = \tan \theta = x_T \tan \theta
\]

\[
y_T = x_T \tan \theta - \frac{1}{2} gt^2 \quad \text{(Target)}
\]

\[
y_p = v \sin \theta t - \frac{1}{2} gt^2
\]

\[
= x_T \tan \theta - \frac{1}{2} gt^2 \quad \text{[} v \cos \theta t = x_T \text{]}'
\]
IF \( x_p = x_T \),
\[ y_p = y_T \]
\[ \Rightarrow \text{ ARROW WILL HIT BEAR!} \]

**EXCEPTION:**
\[ y_p > 0 \Rightarrow \]
\[ v \sin \theta \cdot t \geq \frac{1}{2} gt^2 \]
\[ \frac{1}{2} gt^2 = h \]
\[ \Rightarrow (v \sin \theta) \sqrt{\frac{2h}{g}} \geq h \]
\[ v \sin \theta \geq \sqrt{\frac{gh}{2}} \]

IF INITIAL VELOCITY IS TOO SMALL, PROJECTILE WILL HIT GROUND BEFORE REACHING BEAR.
**Relative Motion**

\[
\vec{r} = \vec{R} + \vec{r}'
\]

[Relative Position]

O’ moving with constant velocity relative to O  
[Inertial Frames]

\[
\vec{R} = \vec{v} t
\]

\[
\begin{align*}
\vec{y} &= \vec{y}' + \vec{v} t \\
\vec{v} &= \frac{d\vec{y}}{dt} = \frac{d\vec{y}'}{dt} + \vec{v}
\end{align*}
\]

\[
\begin{align*}
\vec{v} &= \frac{d\vec{r}}{dt} = \frac{d\vec{r}'}{dt} + \vec{v} \\
\vec{a} &= \vec{a}'
\end{align*}
\]

Galelian Relativity
Reference frame $S'$ moves with velocity $\vec{V}$ relative to frame $S$.

Reference frame $S$ moves with velocity $-\vec{V}$ relative to frame $S'$.

The origins overlapped at $t = 0$.

**Figure 6.23**

**Figure 6.27**