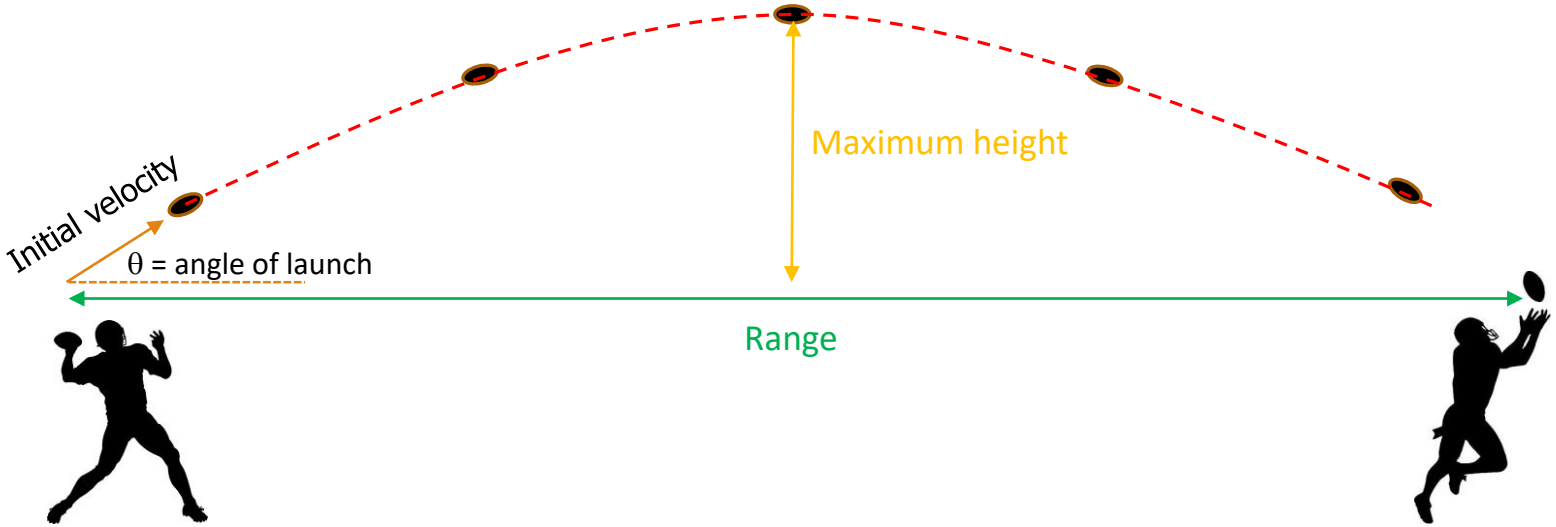
Type 2 Projectile Motion

Type 2 projectile motion

A type 2 projectile motion is where an object is launched with some initial velocity at an angle above the horizontal.

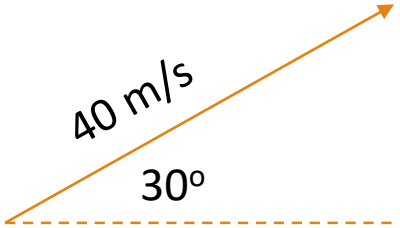
Example:



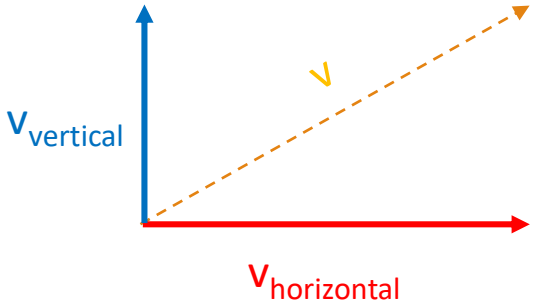
Type 2 projectile motion

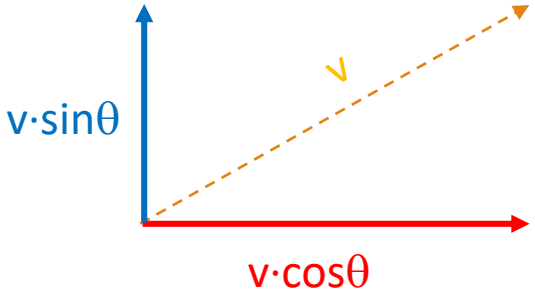
The initial velocity of the launch is given at a angle. In order to solve the problem, we must separate the initial velocity vector into its horizontal and vertical components. To do this we have to use trigonometry, specifically the sine and cosine ratio.

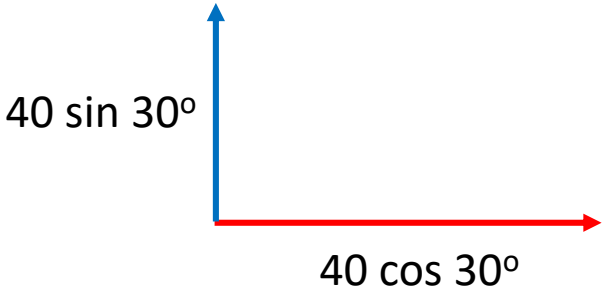
For example:



resolve the vector into its vertical and horizontal components







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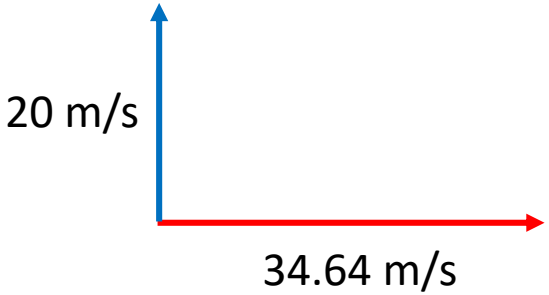

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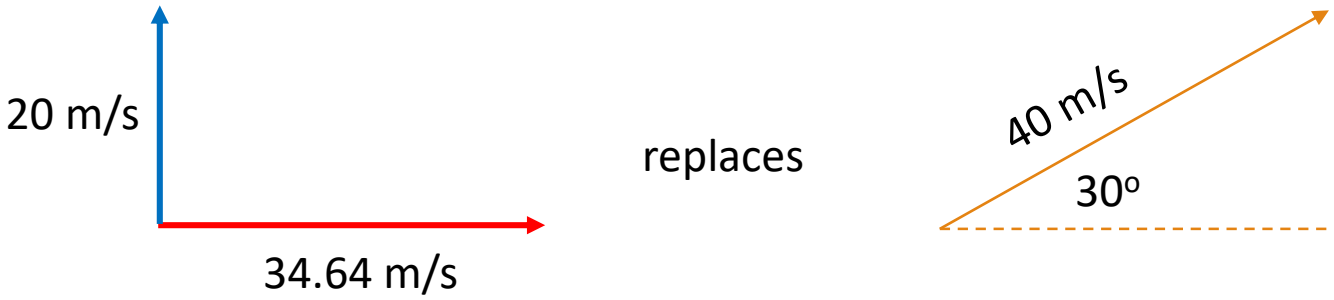
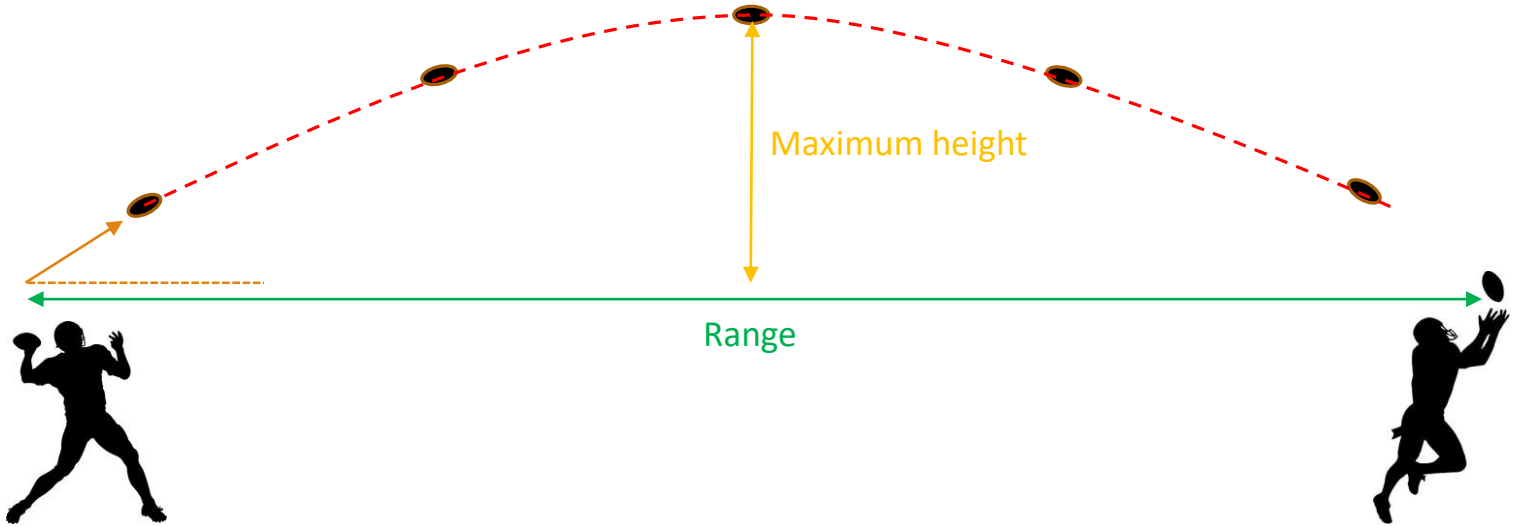


Type 2 projectile motion

Two common things to solve for in type 2 projectile motion.

1. The maximum height of the projectile.



2. The range of the projectile.

NOTE: Always remember that projectiles move through the air in a trajectory that is a function of time. Meaning time is always involved in the problem, whether it is given or need to be calculated.

Type 2 projectile motion

To calculate the height of the projectile, you must use the vertical component of the velocity, $v_{vertical}$ also known as v_y.

To calculate range of the projectile, you must use the horizontal components of the velocity, $v_{horizontal}$ also known as v_x.

Type 2 projectile motion

Calculating for the height knowing the vertical velocity.

The vertical velocity is usually given and is treated as the initial velocity, $v_y = v_i$.

The height of the projectile is also called the vertical displacement, **h = d**.

At maximum height the final vertical velocity is zero, $v_f = 0$.

From linear motion, we can use the equation $v_f^2 = v_i^2 + 2ad$ ← want

known given known

where a = g, the acceleration due to gravity and d = h, the maximum height of the projectile.

We can simplify the equation to $\boldsymbol{d = -\frac{v_i^2}{2a}}$ **or** $\boldsymbol{h = -\frac{v_i^2}{2g}}$.

Type 2 projectile motion

Calculating the time it takes for the projectile to reach maximum height.

We need to look back at linear motion again. We need to use $v_f = v_i + at$. We organize the equation to solve to t.

$$\boldsymbol{t = \frac{-v_i}{a}}, where\ v_i\ is\ the\ initial\ vertical\ velocity$$

$$and\ a\ is\ the\ acceleration\ due\ to\ gravity, -9.81\,\frac{m}{s^2}.$$

This is the time to reach maximum height, which is only ½ of the time the projectile was in the air.

The **total flight** time is

$$\boldsymbol{t = 2 \times \frac{-v_i}{a}}$$

Type 2 projectile motion

To calculating the range of the projectile, we use the same horizontal displacement equation as we did in the type 1 projectile motion.

$$\boldsymbol{x = v_x t}, \qquad where\ v_x\ is\ the\ horizontal\ velocity\ and\ t\ is\ the\ total\ flight\ time.$$