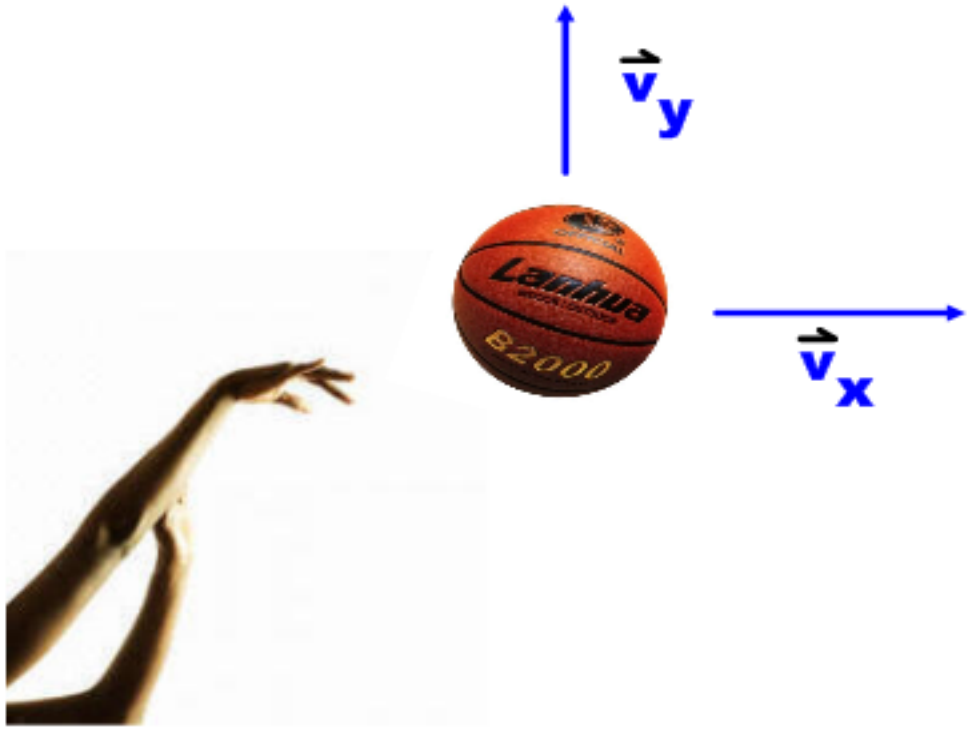
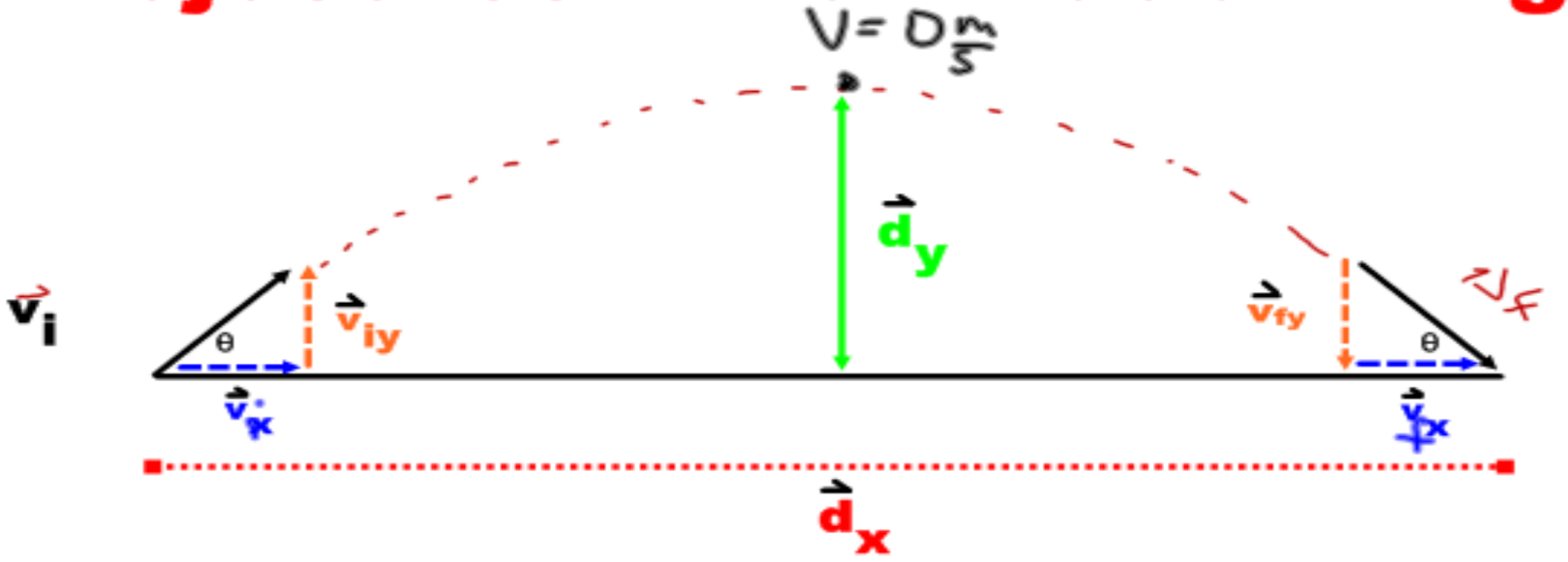
Projectile Motion II



Projectiles Thrown at an Angle



Notice the symmetry:

$\vec{v}_{iy} = -\vec{v}_{fy}$ - equal in magnitude, opposite in direction.

$\vec{v}_x = \vec{v}_x$ - the horizontal velocity does not change.

$\theta = \theta$ - the angle of launch = angle of landing

$t = t$ - the time it takes the projectile to travel up and down is equal to the time it takes the projectile to travel $\vec{d}_x$.

1. How long is the projectile in the air?

If you are given $\vec{v}_{iy}$, you can find t.

Recall:

$$\vec{a} = \frac{\vec{v}_f - \vec{v}_i}{t}$$

As $\vec{v}_{iy} = -\vec{v}_{fy}$ and $\vec{a} = \vec{g}$,

$$\vec{a} = \frac{(-\vec{v}_{iy} - \vec{v}_{iy})}{t}$$

$$\vec{g} = \frac{(-\vec{v}_{iy} - \vec{v}_{iy})}{t}$$

$$t = \frac{-2\vec{v}_{iy}}{\vec{g}}$$

Full-Time Expression

- This is called the full time expression because it gives the amount of time it takes the projectile to travel up and down.

ex) I throw an old M.C. Hammer tape at an angle of 20° N of E with a velocity of 15 m/s. How long is the tape in the air?

2. How long was the object in the air, given $\vec{d}_y$?

Recall: at $\vec{d}_y$, the $\vec{v}_y = 0$. This occurs at half the total time of the motion.

$$\vec{d}_y = \vec{v}_{fy}t - 1/2\vec{a}t^2$$

$$\vec{d}_y = \cancel{\vec{v}_{fy}}^{0}t - 1/2\vec{g}t^2$$

If we consider the point when half the time has elapsed...

$$t = \sqrt{\frac{-2\vec{d}_y}{\vec{g}}}$$

Half-time Expression

This will give <u>half</u> the time the projectile is in the air.

ex) Mr.P shoots a 3-ball from half-court. The ball reaches a height 20 m from its release point. How long was the ball in the air?

3. How high does it go?

Because we are talking about the y-direction, and there is an acceleration in this direction, we must use kinematics equations with acceleration.

Use either:

$$\vec{d}_y = \vec{v}_{iy}t + 1/2\vec{g}t^2$$

$$\vec{d}_y = \vec{v}_{fy}t - 1/2\vec{g}t^2$$

$$\vec{v}_{fy}^2 = \vec{v}_{iy}^2 + 2\vec{g}\vec{d}$$

4. How far does it go (range)?

Because the x-direction undergoes uniform motion, we just use good ol'

$$\vec{d}_x = \vec{v}_x t$$

ex) Mr.P's potato gun fires with a velocity of 5.00 m/s [60°].

a) How long is the potato in the air?

b) How high does the potato go?

Secret Potato Thing

If you use an eqn with time, you must use the half-time because we want to know the height at the half-way point of the motion.

You could also use the no time eqn and avoid time.

c) What is the potato's range?

The Homerun

A baseball player hits a homerun into left field. If the player hits the ball at a 45^{o} angle, and the fence is 98 m away from home plate, with what velocity was the ball hit?