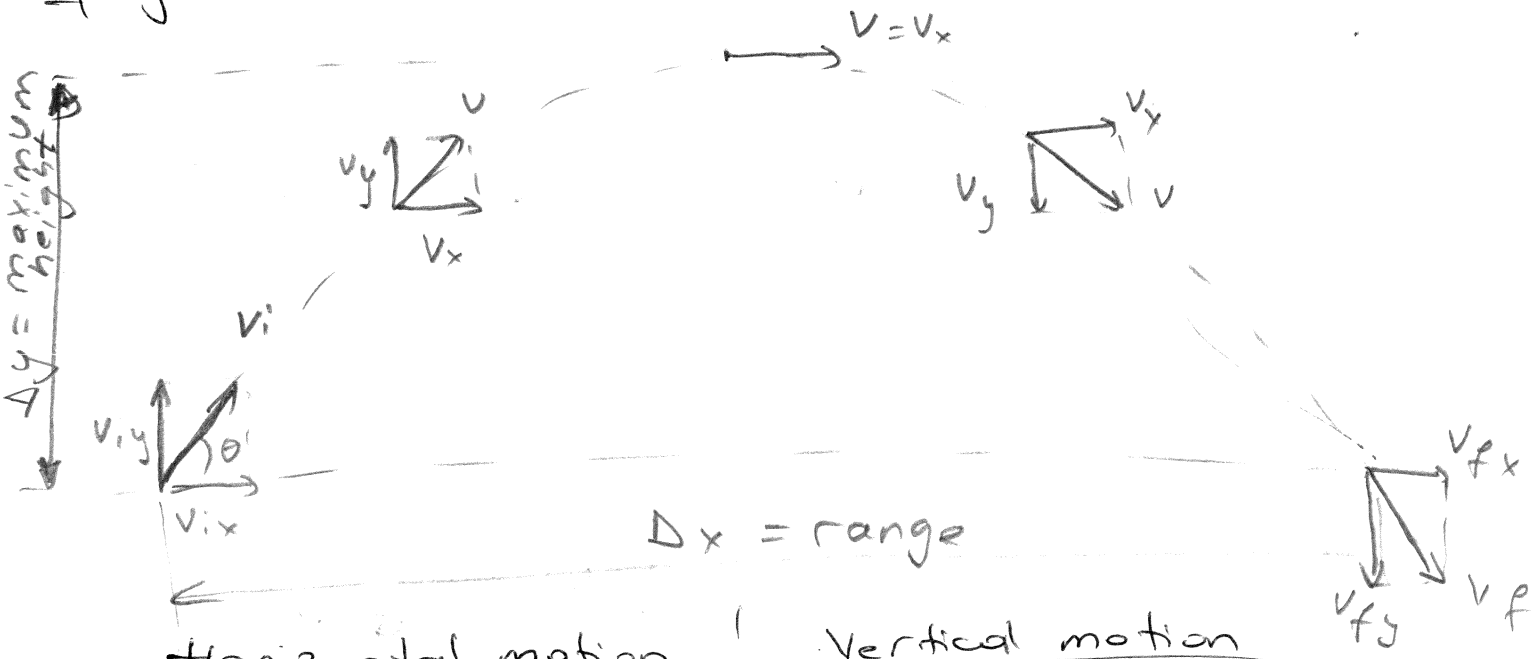
Name: _____

Projectile motion NOTES

Objects that are thrown or launched into the air and are subject to gravity are called projectiles



Horizontal motion

$$\Delta x = v_{ix} \cdot t + \frac{1}{2} a_x t^2$$

$$v_{fx} = v_{ix} + a_x t$$

$$v_{fx}^2 = v_{ix}^2 + 2 a_x \Delta x$$

If $a_x = 0 \text{ m/s}^2$

$$v_{ix} = v_i \cdot \cos\theta$$

$v_{ix} = v_x = v_{fx}$

the only formula for horizontal!

$$\Delta x = v_{ix} \cdot t$$

Vertical motion

$$\Delta y = v_{iy} \cdot t + \frac{1}{2} a_y t^2$$

$$v_{fy} = v_{iy} + a_y \cdot t$$

$$v_{fy}^2 = v_{iy}^2 + 2 a_y \Delta y$$

where

$$v_{iy} = v_i \sin\theta$$

$$a_y = -9.81 \text{ m/s}^2$$

Projectile launched horizontaly

- if there is no launch angle:

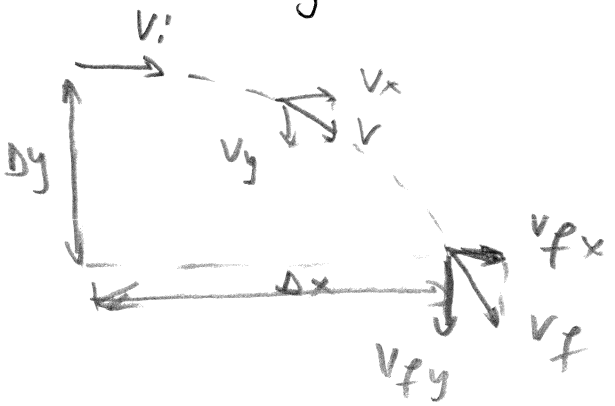
(givens:)

!! $\theta = 0^\circ$

!! $v_{iy} = 0$ m/s (initial vertical velocity)

$a_x = 0$ m/s^2

$a_y = -9.81$ m/s^2



$v_i = v_{ix} = v_{fx} = \text{constant}$

Horizontal

$\Delta x = v_{ix} \cdot t$

Vertical

$\Delta y = 0 + \frac{1}{2} a_y t^2$

$v_f = 0 + a_y \cdot t$

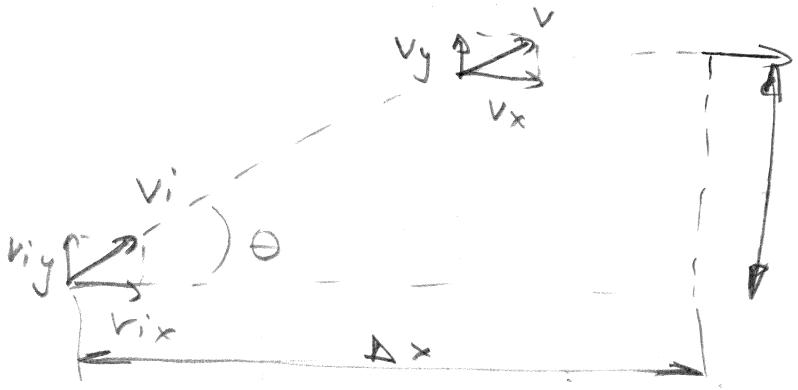
$v_f^2 = 0 + 2 a_y \Delta y$

Ex| A ball is rolled off the side of a 3m high table and lands 4m from the edge of the table What is the velocity initial of the ball?

Practice D

Answers: 1) 0.66 m/s ; 2) 4.9 m/s; 3) 7.6 m/s; 4) 5.6 m

Projectile launched at an angle to maximum height



$v_{ix} = v_x = v_{fx} = v_f$

$v_f = v_{fx}$!! $v_{fy} = 0$ m/s

$h_{max} = \Delta y$

$a_x = 0$ m/s^2

$a_y = -9.81$ m/s^2

Horizontal

$$\Delta x = v_{ix} \cdot t$$

Vertical

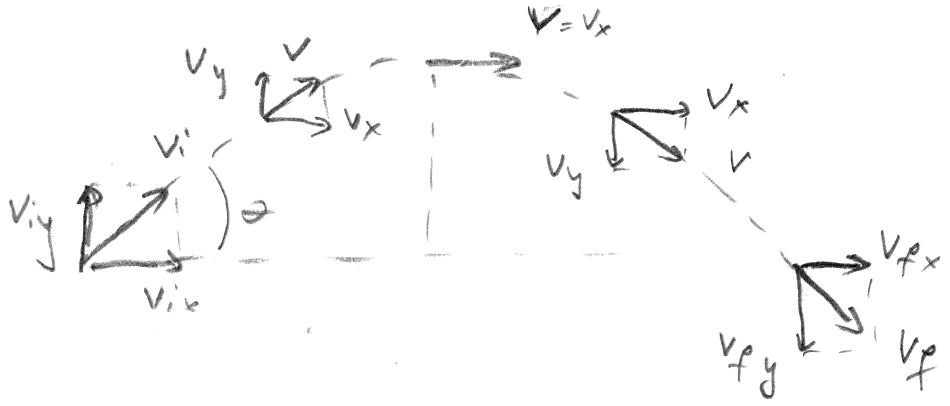
$$\Delta y = v_{iy} + \frac{1}{2} a_y t^2$$

$$0 = v_{iy} + a_y t$$

$$0 = v_{iy}^2 + 2 a_y \Delta y$$

Ex! If a ball is launched at an angle of 30° with initial speed of 5 m/s, what is the maximum height the ball can reach if the total range is 4 m?

"Full" projectile motion launched at an angle



$V_{ix} = V_x = V_{fx}$ = constant

$a_x = 0\ m/s^2$

$a_y = -9.81\ m/s^2$

‼ $\Delta y = 0\ m$

Horizontal

$$\Delta x = V_{ix} \cdot t$$

Vertical

$$0 = V_{iy} \cdot t + \frac{1}{2} a_y t^2$$

$$V_{fy} = V_{iy} + a_y \cdot t$$

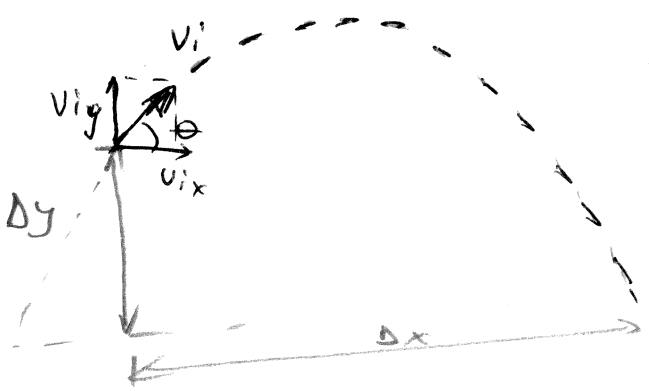
$$V_{fy}^2 = V_{iy}^2 + 0$$

($V_{final} = -V_{initial}$)

$$V_f = \sqrt{V_{fx}^2 + V_{fy}^2} \qquad \theta = \tan^{-1}\left(\frac{V_{fy}}{V_{fx}}\right)$$

Ex| If a child is kicking a soccer ball with initial speed of 2 m/s at an angle of 30°, how far from the child tha ball will land?

"Incomplete" projectile motion launched at an angle



or

Horizontal

$$\Delta x = v_{ix} \cdot t$$

Vertical

$$\Delta y = v_{iy} \cdot t + \frac{1}{2} a_y t^2$$

$$v_f = v_i + a_y \cdot t$$

$$v_f^2 = v_i^2 + 2 a_y \Delta y$$

Ex If a child throws a rock with initial speed of 3 m/s under an angle of 60° with the horizontal, how far from the cliff the rock will fall in the water if the child stands at the edge of the cliff and the height of the cliff is 4 m?

Practice E
Answers: 1) $\Delta y = -2.3$ m; 2) 35.1 m; 3) 2.0 s; 4.8 m; 4) 6.2 m/s

→ Maximum range can be reached at 45°

→ For complimentary angles, the range is the same

$\theta_1 + \theta_2 = 90°$