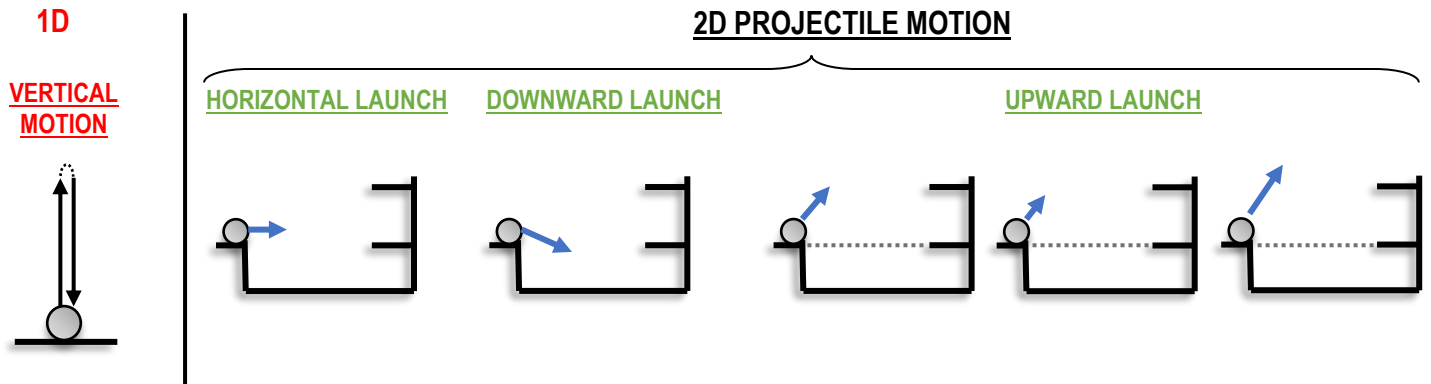


CONCEPT: INTRODUCTION TO PROJECTILE MOTION

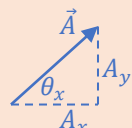
- Projectile Motion occurs when an object is launched & moves in 2D under the influence of *only* _____.
 - Remember! Whenever we have Physics problems in 2D, we decompose them into 1D (X & Y).



- Projectile Motion **COMBINES** (1) horizontal motion where $a_x = \underline{\hspace{1cm}}$, and (2) vertical motion where $a_y = \underline{\hspace{1cm}}$.

EQUATIONS TO USE FOR PROJECTILE MOTION

UAM EQUATIONS	
X ($a_x = 0$)	Y ($a_y = -g$)
(1) $v_x = v_{0x} + a_x t$	(1) $v_y = v_{0y} + a_y t$
(2) $v_x^2 = v_{0x}^2 + 2a_x \Delta x$	(2) $v_y^2 = v_{0y}^2 + 2a_y \Delta y$
(3) $\Delta x = v_{0x} t + \frac{1}{2} a_x t^2$	(3) $\Delta y = v_{0y} t + \frac{1}{2} a_y t^2$
* (4) $\Delta x = \frac{1}{2} (v_{0x} + v_x) t$	* (4) $\Delta y = \frac{1}{2} (v_{0y} + v_y) t$

VECTOR EQs

$A = \sqrt{A_x^2 + A_y^2}$
$\theta_x = \tan^{-1} \left(\frac{ A_y }{ A_x } \right)$
$A_x = A \cos(\theta_x)$
$A_y = A \sin(\theta_x)$

PROBLEM: Which of the following quantities are constant during projectile motion?

- A) Vertical acceleration & vertical velocity
- B) Angle (direction) of the velocity vector
- C) Horizontal acceleration & vertical velocity
- D) Vertical acceleration & horizontal velocity

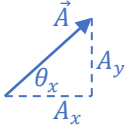


CONCEPT: SOLVING PROJECTILE MOTION PROBLEMS (WITH HORIZONTAL LAUNCH EXAMPLE)

EXAMPLE: A ball rolls horizontally off a 2m-tall table with a speed of 3.0 m/s. Calculate **a)** the time it takes for the ball to hit the ground, and **b)** the horizontal displacement (range) of the ball



PROJECTILE MOTION
1) Draw paths in X&Y and points of interest (Points of Interest: initial, final, max height, etc.)
2) Determine target variable
3) Determine interval and UAM equation
4) Solve

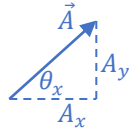
UAM EQUATIONS		VECTOR EQs
X	Y	 $A = \sqrt{A_x^2 + A_y^2}$ $\theta_x = \tan^{-1} \left(\frac{ A_y }{ A_x } \right)$ $A_x = A \cos(\theta_x)$ $A_y = A \sin(\theta_x)$
$\Delta x = v_x t$	(1) $v_y = v_{0y} + a_y t$ (2) $v_y^2 = v_{0y}^2 + 2a_y \Delta y$ (3) $\Delta y = v_{0y} t + \frac{1}{2} a_y t^2$ *(4) $\Delta y = \frac{1}{2} (v_{0y} + v_f) t$	

- In projectile motion, time **t** can be found from either **X** OR **Y** axis equations. Always try the ____ axis equation first.
 - If you get stuck and can't solve using X axis equation, always try to solve it with a Y axis equation, and vice versa.
- When an object is launched **horizontally**, its initial velocity is ONLY in the ____ axis: $v_{0x} = \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$ $v_{0y} = \underline{\hspace{1cm}}$
 - Remember:** all objects in projectile motion always have (1) $a_x = 0$, so v_x _____ changes; and (2) $a_y = -g$

PROBLEM: A rock is thrown horizontally with a speed of 20 m/s from the edge of a high cliff. It lands 80 m from the cliff's base. How tall is the cliff?

- A) 78.4 m
- B) 19.6 m
- C) 122.5 m
- D) 24.5 m

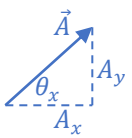
PROJECTILE MOTION
1) Draw paths in X&Y and points of interest <i>(Points of Interest: initial, final, max height, etc.)</i> 2) Determine target variable 3) Determine interval and UAM equation 4) Solve

UAM EQUATIONS		VECTOR EQs
X	Y	 $A = \sqrt{A_x^2 + A_y^2}$ $\theta_x = \tan^{-1} \left(\frac{ A_y }{ A_x } \right)$ $A_x = A \cos(\theta_x)$ $A_y = A \sin(\theta_x)$
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PROBLEM: A ping-pong player standing 1.6 m from the net serves the ball horizontally. The ball is hit 1.2 m above the floor. What initial speed does the ball need to go over the net, which is 1.6m away from the player and 0.90m above the floor?

- A) 2.1 m/s
- B) 3.2 m/s
- C) 9.2 m/s
- D) 6.4 m/s

PROJECTILE MOTION
1) Draw paths in X&Y and points of interest <i>(Points of Interest: initial, final, max height, etc.)</i> 2) Determine target variable 3) Determine interval and UAM equation 4) Solve

UAM EQUATIONS		VECTOR EQs
X	Y	 $A = \sqrt{A_x^2 + A_y^2}$ $\theta_x = \tan^{-1} \left(\frac{ A_y }{ A_x } \right)$ $A_x = A \cos(\theta_x)$ $A_y = A \sin(\theta_x)$
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PROBLEM: You kick a ball horizontally at 8 m/s from the roof of a 40m-tall building. Unfortunately, a car below you on the street accelerates uniformly forwards from rest, and your ball lands on the car. What was the acceleration of the car?

- A) 7.92 m/s²
- B) 5.60 m/s²
- C) 1.96 m/s²
- D) 11.2 m/s²

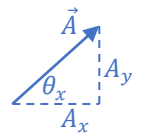
PROJECTILE MOTION

- 1) Draw paths in X&Y and points of interest
(Points of Interest: initial, final, max height, etc.)
- 2) Determine target variable
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UAM EQUATIONS

X	Y
$\Delta x = v_x t$	$(1) v_y = v_{0y} + a_y t$ $(2) v_y^2 = v_{0y}^2 + 2a_y \Delta y$ $(3) \Delta y = v_{0y} t + \frac{1}{2} a_y t^2$ $*(4) \Delta y = \frac{1}{2} (v_{0y} + v_f) t$

VECTOR EQs



$$A = \sqrt{A_x^2 + A_y^2}$$

$$\theta_x = \tan^{-1} \left(\frac{|A_y|}{|A_x|} \right)$$

$$A_x = A \cos(\theta_x)$$

$$A_y = A \sin(\theta_x)$$