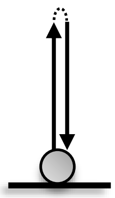
CONCEPT: INTRODUCTION TO PROJECTILE MOTION

● 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)**.**

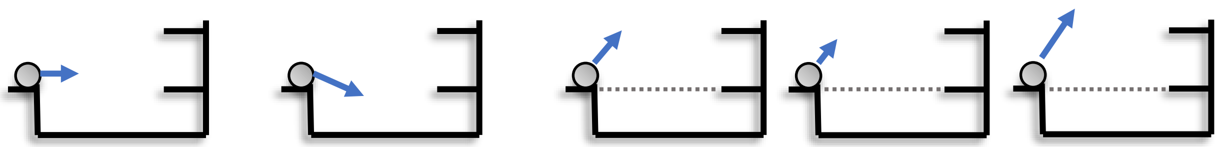
1D

VERTICAL MOTION



2D PROJECTILE MOTION

HORIZONTAL LAUNCH | DOWNWARD LAUNCH | UPWARD LAUNCH

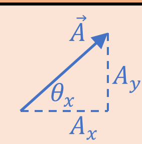


● Projectile Motion **COMBINES** (1) horizontal motion where a_x = ___, and (2) vertical motion where a_y = ____.

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



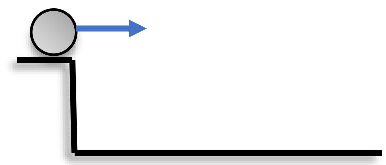
$A = \sqrt{A_x^2 + A_y^2}$

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

$A_x = A\cos(\theta_x)$

$A_y = A\sin(\theta_x)$

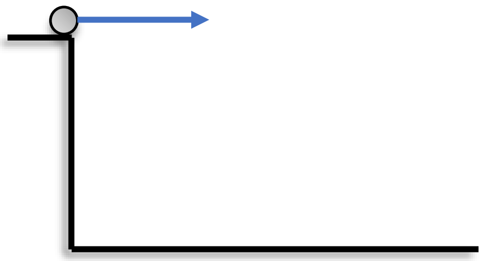
PROBLEM: Which of the following quantities are constant during projectile motion?



- **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

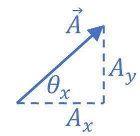


PROJECTILE MOTION
1) Draw paths in X&Y and points of interest *(Points of Interest: initial, final, max height, etc.)*
2) Determine target variable
3) Determine interval and UAM equation
4) Solve

UAM EQUATIONS

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



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● 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} = ____ = ____ v_{0y} = ____

- **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

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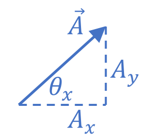

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PROBLEM: A ping-pong player standing 1.6 m from the net serves the ball horizontally. The ball is hit 1.2 m above the floor. What initial speed does the ball need to go over the net, which is 1.6m away from the player and 0.90m above the floor?

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

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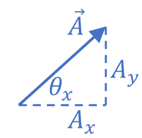

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PROBLEM: You kick a ball horizontally at 8 m/s from the roof of a 40m-tall building. Unfortunately, a car below you on the street accelerates uniformly forwards from rest, and your ball lands on the car. What was the acceleration of the car?

A) 7.92 m/s^2
B) 5.60 m/s^2
C) 1.96 m/s^2
D) 11.2 m/s^2

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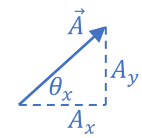

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