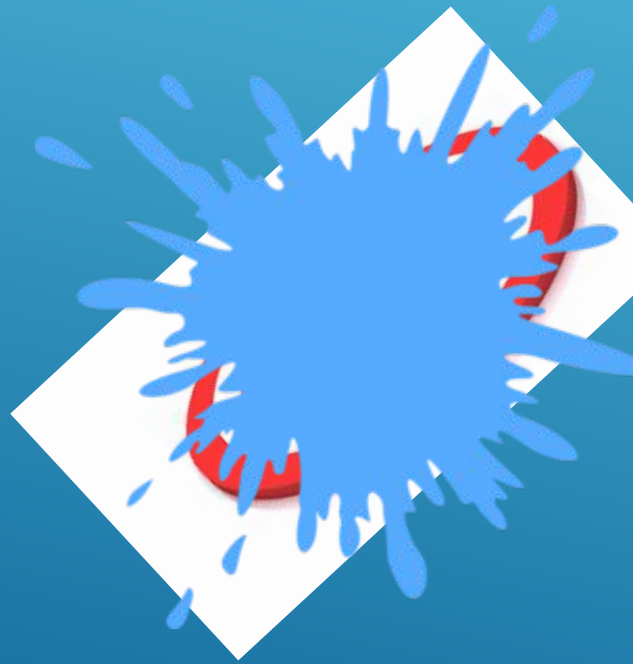
WATER BALLOON BALLISTICS

(Trajectory Motion of Water Balloons)





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Engineers at U.S. Army Yuma Proving Ground (YPG)

WHAT WE DO AT YPG



SAFETY FIRST!

- Before any experiment or test, the first thing to think about is how to do it safely.
  - What safety considerations should be considered when using the water balloon launcher?

SAFETY CONSIDERATIONS

- Firing safety fan
- Personal protective equipment (PPE)
- Properly trained personnel
- Observation of impact
- Limited personnel at the gun
- Remote firing

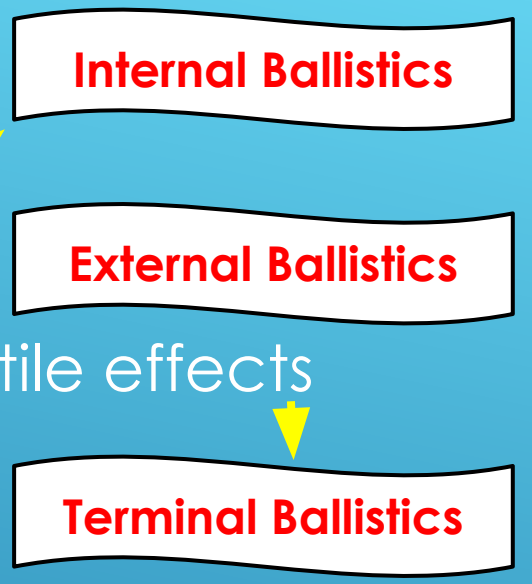
ARTILLERY WEAPON FIRING

– FACTORS TO CONSIDER

- Cannon (Wear)
- QE/Azimuth
- Projectile (weight)
  - Drag (boat-tail)
- Propellant type and temperature - Velocity
- Height of gun/target
- Impact Point (air/ground)
- Gravity
- Met: Wind, Air Density, Air Temperature
- Rotation of the Earth
- Spin/Drift
- Solution: Impact point, time of flight, max ordinate, azimuth to impact, Range, deflection

BALLISTICS

I. The science of firing characteristics in a system
II. The science of motion for a projectile in flight
III. The science of mechanics that deals with projectile effects



TRAJECTORY

- The path that a moving object follows through space as a function of time

BALLISTIC TRAJECTORY

- The path that a launched projectile without propulsion will take under the action of gravity

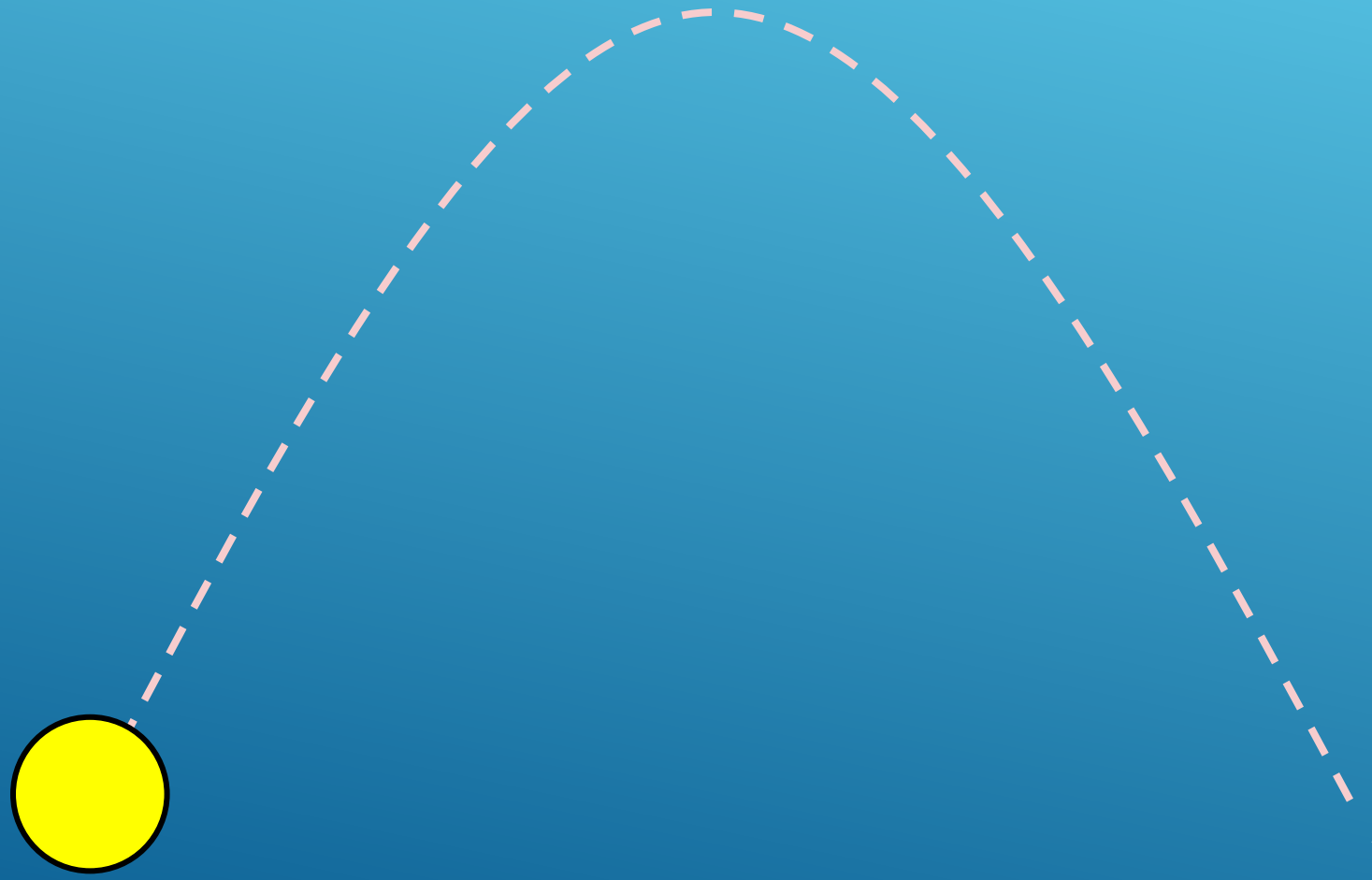
Internal Ballistics

The science of firing characteristics in a system



External Ballistics

The science of motion for a projectile in flight



Terminal Ballistics

The science of mechanics that deals with projectile effects



External Ballistics

Internal Ballistics

ballistic trajectory



Terminal Ballistics



The science of firing characteristics in a system

Internal Ballistics



You have the ability to control the:

- Velocity
- Angle

Initial velocity (v_i) is a function of

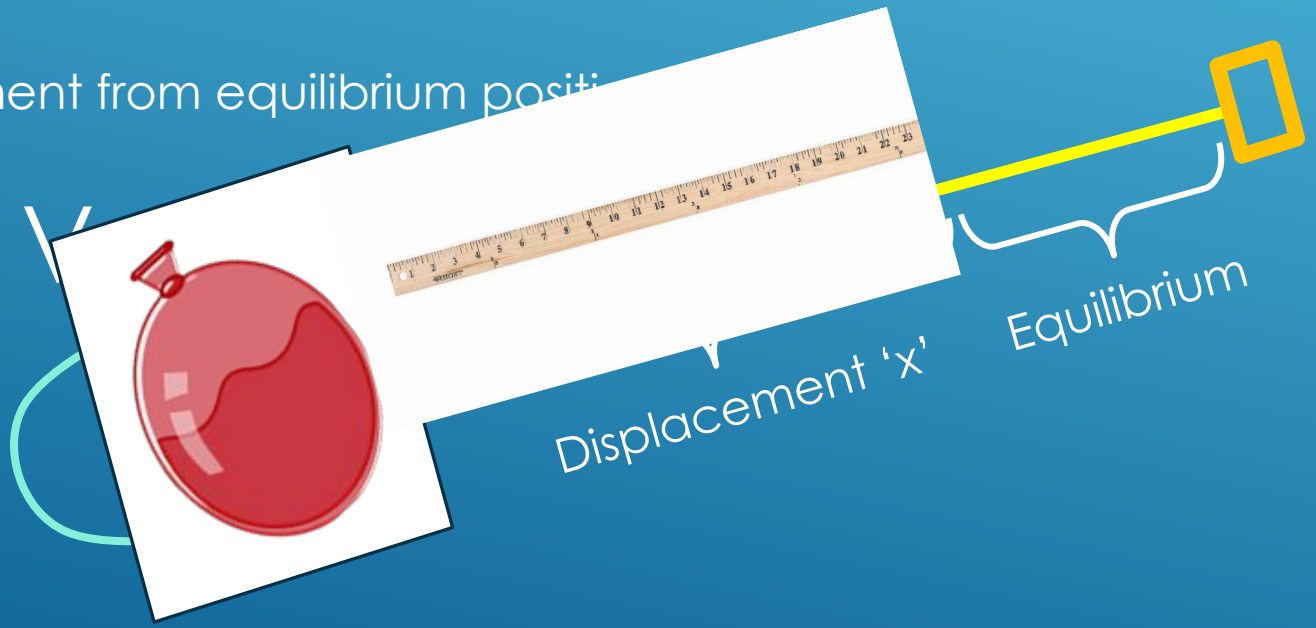
- Mass ‘m’ (of water balloon)
- Displacement ‘x’ (how far back you pull the launcher)
- Spring Constant ‘k’(of launcher)
  - How stiff a spring is (rubber for us)

$$k = -\frac{F}{x}$$

F → restoring force

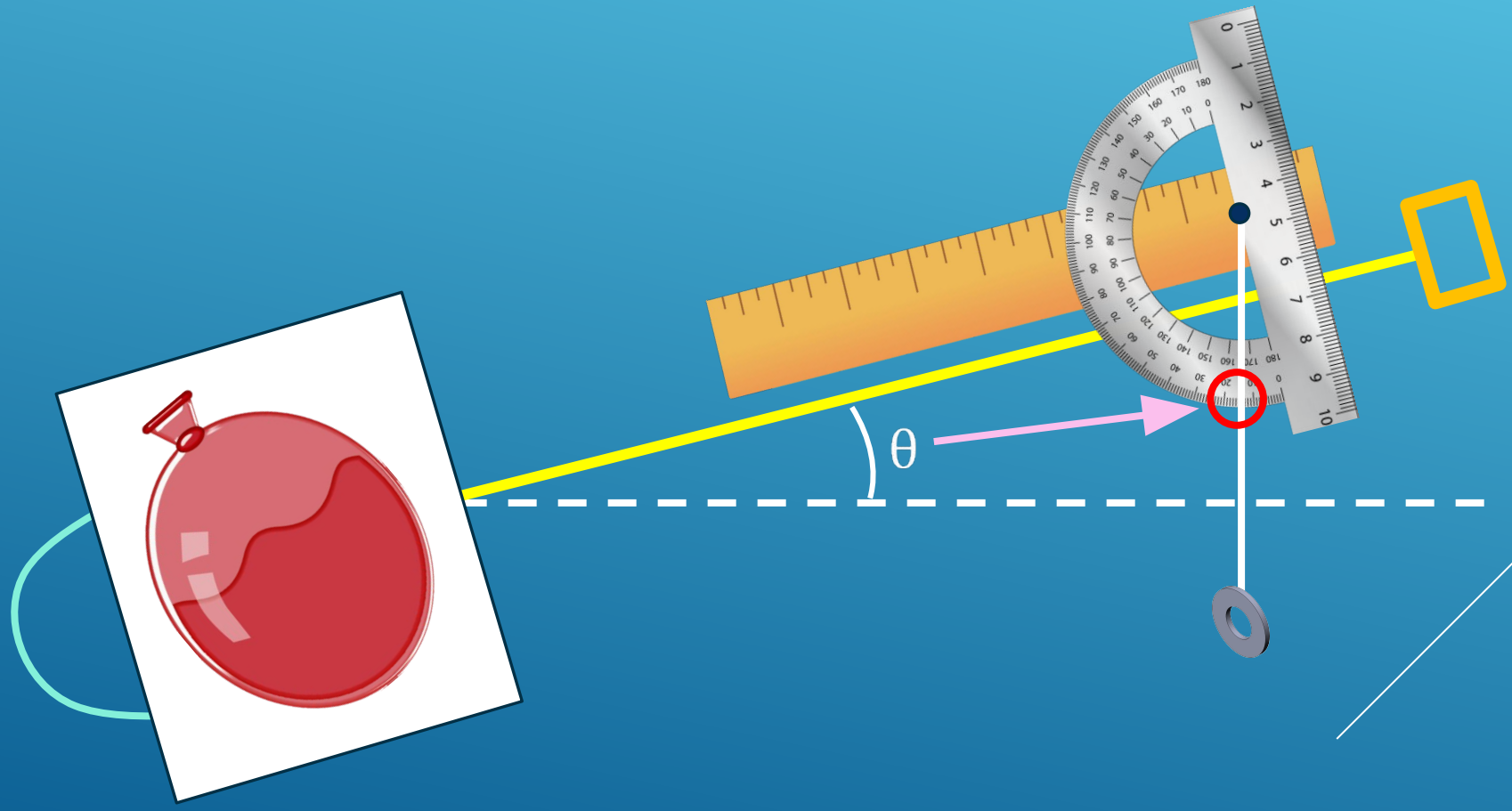
x → displacement from equilibrium positi

$$v_i = x\sqrt{\frac{k}{m}}$$



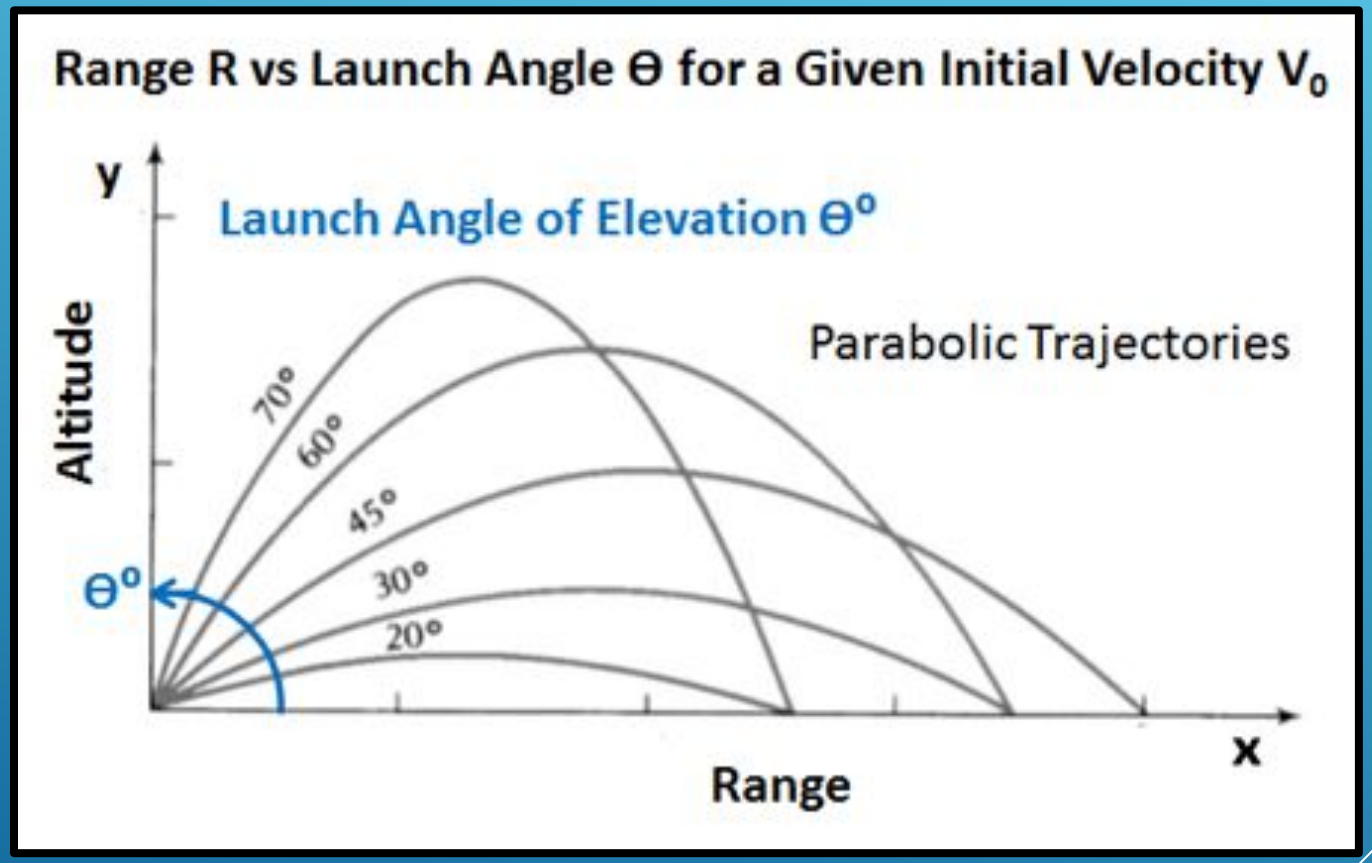
- Angle

  The space (usually measured in degrees) between two intersecting lines or surfaces at or close to the point where they meet.



- Angle

Note the relationship between launch angle and range (at same velocity)



WHO THINKS THEY CAN HIT THE TARGET WITH A WATER BALLOON?

Use your knowledge of water balloon ballistics and give it your best shot!

Remember

- Velocity (controlled by displacement)
- Angle (used with velocity to control distance)

DON'T FORGET TO AIM!