PROJECTILE MOTION

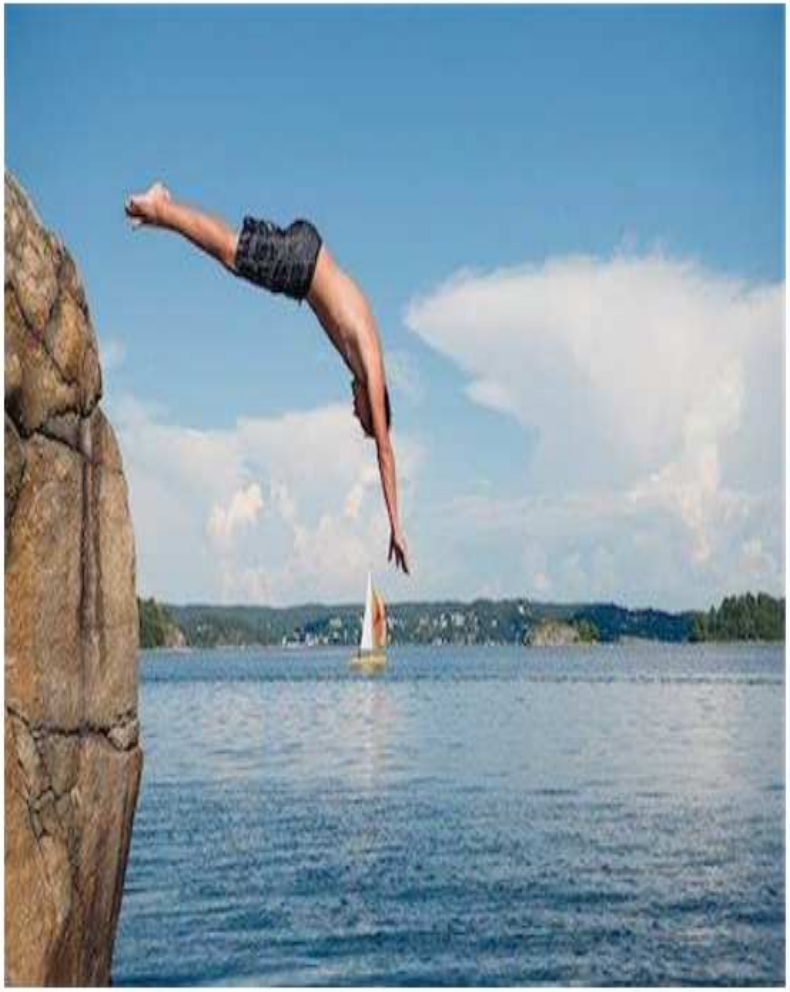
A diver is seen performing a simple dive.

The motion of the diver follows a parabolic curve.

The path followed by a projectile is known as trajectory.

Projectile motion is 2-D in nature.

Here we shall neglect the effect the air resistance and curvature and rotation of the earth.



PROJECTILE MOTION

Examples of projectile motion:

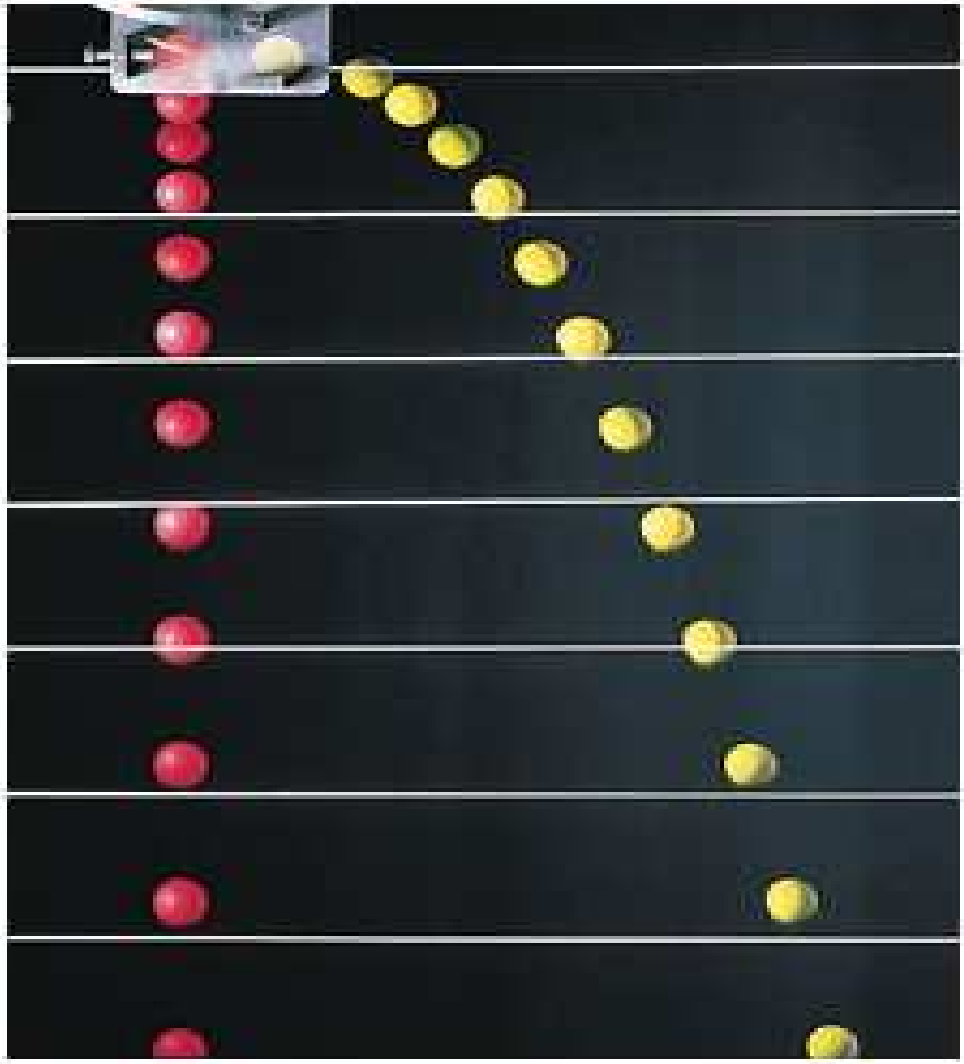
1) A battled baseball

2) A thrown football

3) A package dropped from an airplane

4) A bullet shot from a riffle

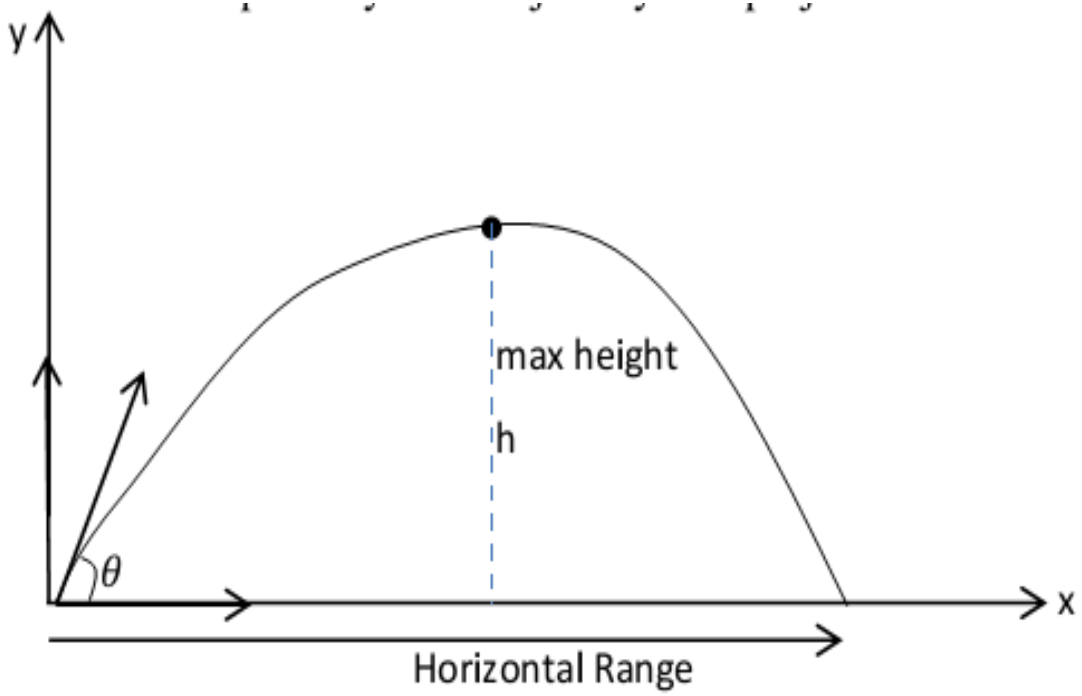
5) A sky diver



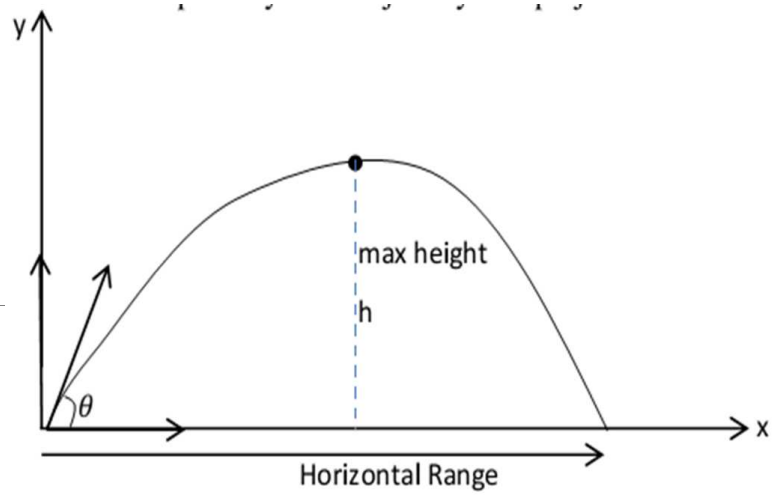
PROJECTILE MOTION

The vertical plane along which the projectile travel will be considered as the xy-plane.

The motion is a combination of both vertical and horizontal motions.



Motion of Projectile along Horizontal Component (x-axis)



We shall consider the following:

1) There is no acceleration along the x-axis, hence: $a_x = 0$

2) To represent the initial velocity (u) along x-component:

$u_x = u\cos\theta$

3) To represent the final velocity (v) along the x-component:

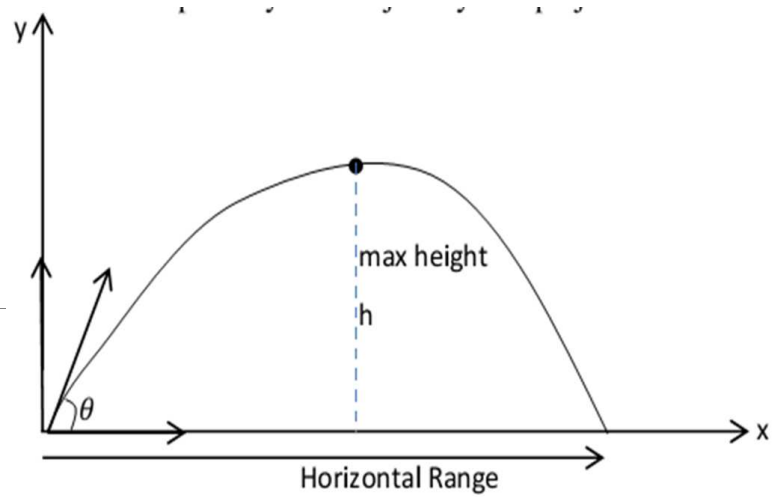
$v_x = u_x$

$v_x = u_x = u\cos\theta$

4) To find the position (x) along the x-component:

$x = u_x t$ or $x = (u\cos\theta)t$

Motion of Projectile along Horizontal Component (y-axis)



We shall consider the following:

1) There is an acceleration along y-axis. Hence $a_y = -g$

2) To represent initial velocity (u) along y-component:

$u_y = ucos\theta$

3) To represent final velocity (v) along y-component:

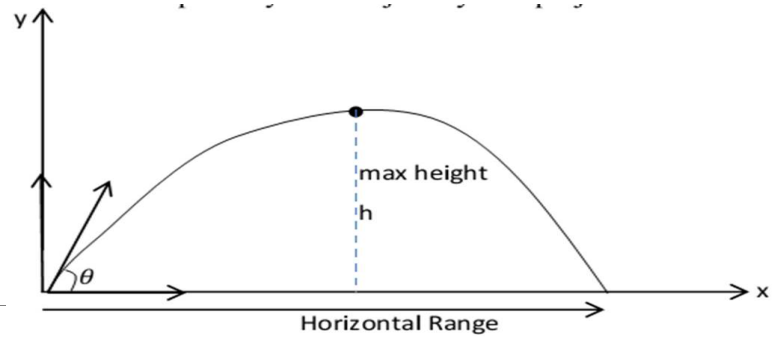
$v_y = u_y - gt$

$v_y = usin\theta - gt$

4) To find the position (y) along the y-component:

$y = (usin\theta)t - \frac{1}{2}gt^2$

PROJECTILE MOTION



1) At any given time t, the position of the projectile is deduced by:

$$r = \sqrt{x^2 + y^2}$$

2) At any given time t, the velocity of the projectile's speed is deduced by:

$$v = \sqrt{{v_x}^2 + {v_y}^2}$$

3) The direction of the velocity is deduced by:

$$tan\theta = \frac{v_y}{v_x}$$

PROJECTILE MOTION

CLASS EXAMPLE:

1) Ifeanyi kicks a ball off horizontally from the edge of a cliff with velocity of magnitude 9.0 m/s. Find the ball's position, distance from the edge of the cliff, and velocity after 0.50s.

Answer:

1) Ball's Position: a) x = 4.5m b) y = -1.23m

2) Ball's Distance: r = 4.7m

3) Ball's velocity: a) $v_x = 9.0m/s$ b) $v_y = -4.9m/s$

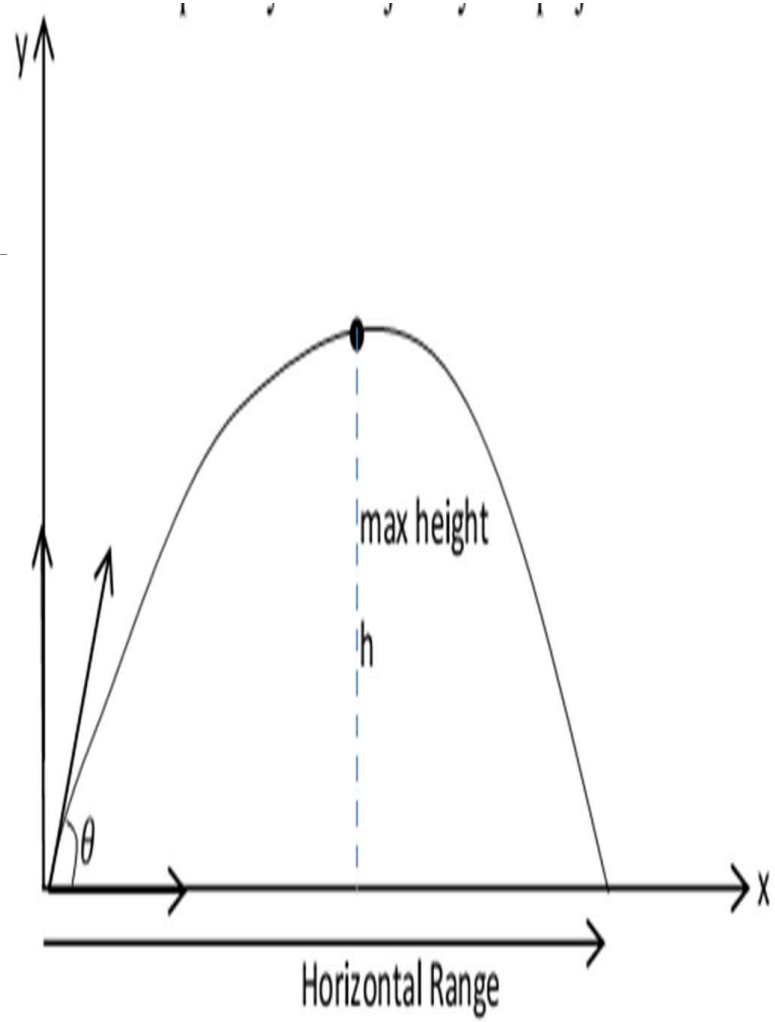
PROJECTILE MOTION

Every Projectile motion is characterized by three quantities:

1) Height

2) Time of Flight

3) Range



Time

From this equation: $v_y = u_y - gt$

$$v_y = usin\theta - gt$$

[- equation 1]

Let's assume that the motion of the projectile starts form the origin, x = 0 and y = 0.

This means that at the maximum height, final velocity $v_y = 0$

Re-writing the equation 1 above: we have:

$0 = usin\theta - gt$ *[-equation 2]*

From equation 2, make t subject of formulae:

$t = \frac{usin\theta}{g}$ *[-equation 3]*

Note: equation is the time at maximum height.

Hence the total time of flight is T = 2t

$T = \frac{2usin\theta}{g}$ *[-equation 4]*

PROJECTILE MOTION

HEIGHT.

The maximum height reached by the projectile is expressed as:

$$y_{max} = \frac{u^2 sin^2\theta}{2g}$$

RANGE

The horizontal range (x) at the time when the projectile lands is expressed as:

$$R = \frac{u^2 sin2\theta}{g}$$

At maximum range where $sin2\theta = 1$

$$R_{max} = \frac{u^2}{g}$$

PROJECTILE MOTION

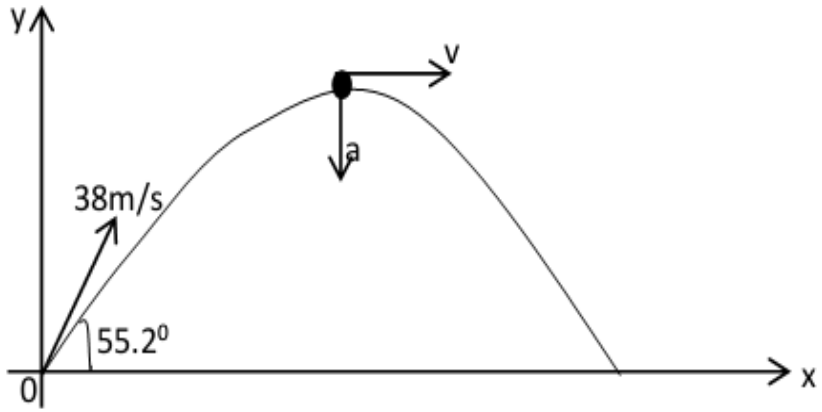
Class Example

2) Lionel Messi kicks a ball at speed 38.0m/s at an angle $\theta = 55.2°$

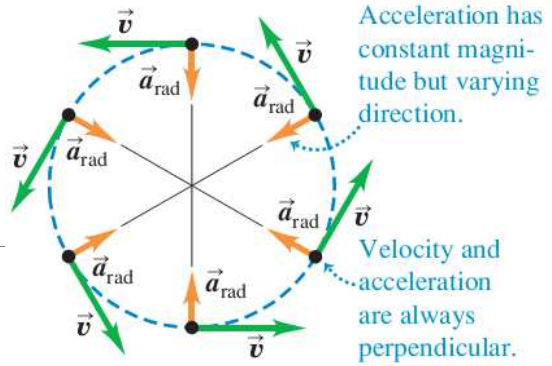
A) Find the position of the ball and magnitude and direction of its velocity, at t = 3.00s

B) Find the time when the ball reaches the highest point of its flight and find its height h at this point.

C) Find the horizontal range R.



MOTION IN A CIRCLE



In uniform circular motion, the magnitude ***a*** of the instantaneous acceleration is equal to the square of the speed ***v*** divided by the radius ***R*** of the circle. Its direction is perpendicular to ***v*** and inward along the radius. This acceleration is called **centripetal acceleration**

$$a_c = \frac{v^2}{R}$$

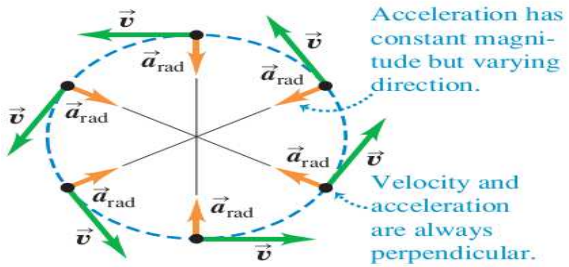
To complete one cycle, velocity is given as:

$$v = \frac{2\pi R}{T}$$

Therefore the centripetal acceleration is given as:

$$a_c = \frac{4\pi^2 R}{T^2}$$

MOTION IN A CIRCLE



#THURSDAYTRIVIA

1) Damilola whirls a stone around at constant speed in a circle of radius 7.0m. If the stone makes one complete circle in 5.0s. What is the acceleration of the stone?

WORKPROBLEMS!

1) A long-jumper had a take-off velocity of 9.5m/s. What is the maximum possible horizontal distance the man can jump?

2) A stone is projected with a speed 17.32m/s at an angle 60° to the horizontal. Calculate the maximum height and the range covered by the stone.

3) A particle is launched such that its maximum range is 26.4m. What is the speed at which it is launched?

4) A projectile is projected into the air at 36 m/s. If it travels a horizontal distance of 99.3 m. (a) At what angle above the horizontal is it projected? (b) What is maximum vertical height it climbed

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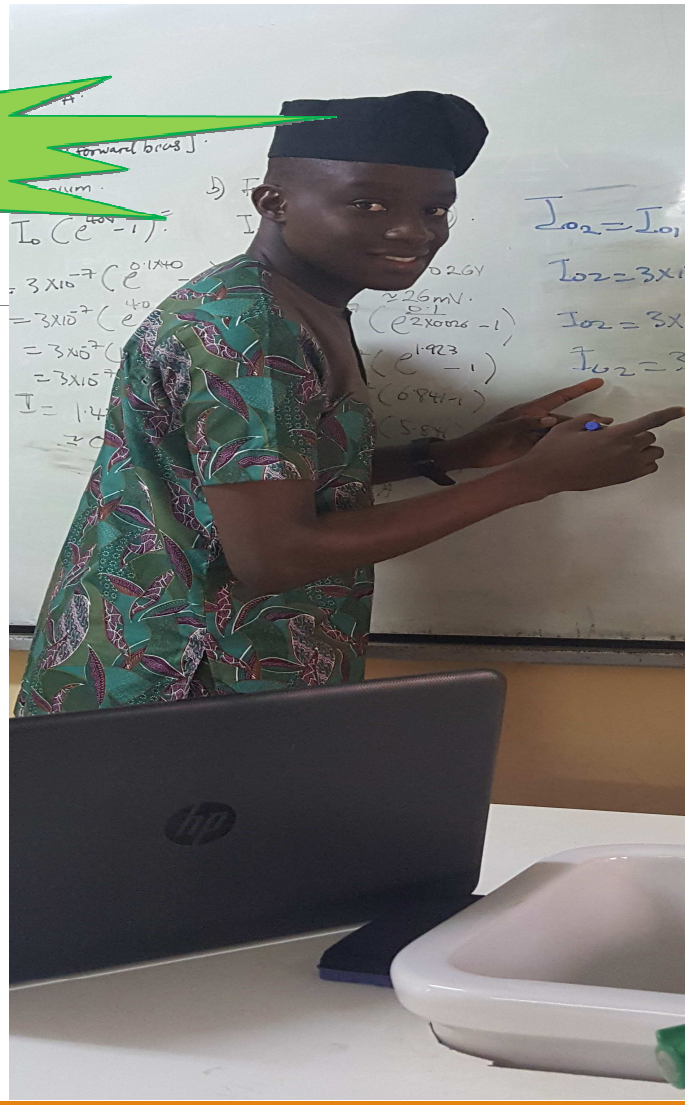
QUESTION TIME??????????????



About Lecturer:

Opadele A.E is a physics enthusiast with special interest in Medical Physics. He loves to present the complex theories in physics in seemingly simple approach for effectual understanding.

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