**Assignment No 03**



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Mechanics-II

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**Q .no # 1:-**

From a gun placed on a horizontal plane. Which can fire a shell with speed √2gH. It is required to throw a shell over a wall of height h, and the elevation of the gun cannot exceed α<45. Show that this will be possible only when h<Hsin²α, and that if this condition be satisfied, the gun must be fired from within a strip of the plane whose breadth is 4cosα√H(Hsin²α-h) .

**Proof:**

Let the origin 'o' be the position of gun and speed V. of Shell is V₁ = √29H Let height of wall = AB=h Let distance of wall from origin ‘0’= x₁

Let the shell passes over the wall, so that point.

B(x,h) lies on path of shell.

Y = x₁ tan α-½ g x₁²sec²α ∕ v∘²

h=x₁ tanα gx₁²sec²α ∕ 2.2gH

h=x₁ tanα x₁² ∕ 4Hcos²α

4Hcos²α.h= 4Hcos²α.x tanα-x²

                  = 4Hcosα sinα.x -x²

X²- (4Hcosα sinα) x + 4Hhcos²α =0   (1)

This eq is quadratic in x. it has real roots if

  B²-4AC > 0

16H² Cos²α sin²α - 4(1)(4)(Hhcos²α) >0

16Hcos²α (Hsin²α - h) > 0

            Hsin²α - h > 0

            HSin²α > h

Now from (1)

X²- (4Hcosα sinα) x + 4Hhcos²α =0

x= 4H cosαsinα±√16H² cos²αsin²α - 16Hh cos²α / 2

x= 4H cosαsinα±4 cosα √H² sin²α - Hh / 2

x= 2H cosα sinα ± 2 cosα √ H (H sin²α - h)

Breadth = oC- oA

X2 - x1 = 2H cosα sinα + 2 cosα√H(Hsin²α - h) - (2H cosα sinα - 2 cosα√H(Hsin²α - h)

               4cosα √H (H sin²α - h)

              Hence Proved

**Q. no # 2:-**

A Shell is fired with speed V at an elevation θ hits an airship at height H- which is moving horizontally away from the gun with speed Vo - show that, if,

(2Vcos θ – Vo) (v² sin² θ - 2gH)½ Vo v sinθ

the shell might also have hit the airship If the patter had remained stationary in the position it occupied when the gun was actually fired.

**Proof:**

Let 'o'be the position of gun. Let'A' be the position of airship when gun fixed Height of airship at A is ‘H’. when the shell is fired from the gun at ‘o’ the airship moves at constant height ‘H’ away from A. the shell has the only possibility to hit the airship at the position B at height ‘H’ on the trajectory of shell.

First we find time taken by shell when it attains height ‘H’ I.e. to reach ‘A’

x= V cos θ.t (i) (position of moving particle at any point is (x,y)

y= V sin θ.t - ½gt²     (ii)

H= v sinθ.t² - ½gt²

2H= 2V sinθ·t - gt²

gt² - 2v sinθ·t + 2H=0 quad in ’t’   (1)

t= 2V sinθ±√4V² sin²θ - 8gH / 2g

t= v sinθ ± √4V²sin²θ - 2gH / g

Let

t1 = time taken by shell to reach A from ’0’

t2 = time taken by shell to reach B from ’0’

t1= v sinθ - √v² sin²θ - 2gH / g  (ii)   t1<t2

t2 = v sinθ - √v² sin²θ - 2gH / g  (iii)

The time taken A to B = t2-t1

Horizontal distance |AB|= V cosθ (t2 – t1).

|AB|= vcosθ.2.√v² sin²θ - 2gH / g   (iv)

now if the time taken by airship from A to B= time taken shell from O to B. the shell hit the airship at B

|AB| = Vo t2

from (iii)

|AB| = Vo[ v sinθ = √v²sin²θ - 2gH / g ]

using (iv)

V cosθ 2√v² sin²θ - 2gH / g = Vo[ v sinθ = √v²sin²θ - 2gH / g ]

√v² sin²θ - 2gH (2v cosθ) -  Vo √v² sin²θ - 2gH

                                                                                -=Vo sinθ

√v² sin²θ- 2gH (2 v cosθ - Vo) =  Vo V sinθ **Hence Proved.**