Numerical

- 15.
- A projectile is fired in such a way that its horizontal range is equal to three times its maximum height. What is the angle of projection?
- 16.
- To start an avalanche on a mountain slope, an artillery shell is fired with an initial velocity of 300 m/s at 55.0° above the horizontal. It explodes on the mountainside 42.0 s after firing. What are the x and y coordinates of the shell where it explodes, relative to its firing point?

Numerical

- 23.
- A placekicker must kick a football from a point 36.0 m (about 40 yards) from the goal. Half the crowd hopes the ball will clear the crossbar, which is 3.05 m high. When kicked, the ball leaves the ground with a speed of 20.0 m/s at an angle of 53.0° to the horizontal. (a) By how much does the ball clear or fall short of clearing the crossbar? (b) Does the ball approach the crossbar while still rising or while falling?
- 27.
- A soccer player kicks a rock horizontally off a 40.0-m-high cliff into a pool of water. If the player hears the sound of the splash 3.00 s later, what was the initial speed given to the rock? Assume the speed of sound in air is 343 m/s.

(1)

A projectile is fired in such a way that its horizontal range is equal to three times its maximum height. What is the angle of projection.

DATA.

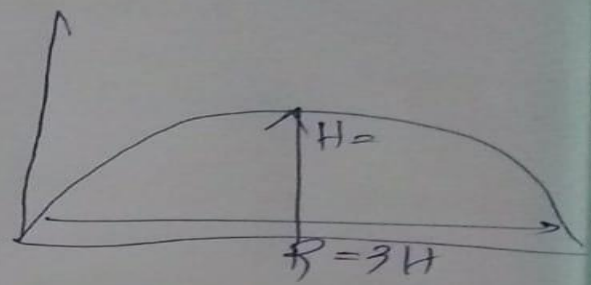
Only one suggestion.

$$R = 3H$$

~~For $\theta =$~~

REQUIRED

$$\theta = ?$$



FORMULAE

$$R = (V_i^2 \sin 2\theta / g)$$

$$H = (V_i^2 \sin^2\theta)/2g$$

SOLUTION

$$\frac{V_i^2 \sin 2\theta}{g} = \frac{3 V_i^2 \sin^2\theta}{2g}$$

$$2 \sin\theta \cos\theta = \frac{3 \sin^2\theta}{2}$$

$$\tan\theta = \frac{4}{3}$$

$$\theta = \tan^{-1}\left(\frac{4}{3}\right) = 53.1$$

16.

DATA

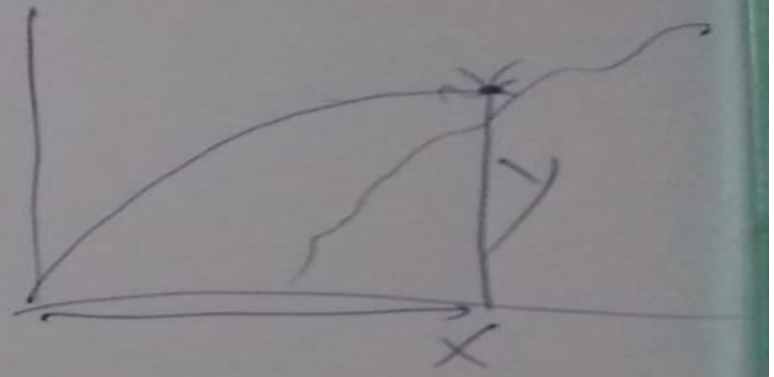
$V_i = 300$ m/s $g = 9.8$

$\theta = 55°$ $t = 42$ sec

REQUIRED

$(x, y) = ?$

Actually distances



FORMULA

V_x

$X = V_i \cos\theta \, t$

$Y = V_y t - \frac{1}{2} g t^2$

t

SOLUTION

$X = x = V_i \cos\theta$

$= 300 \cos 55$

$= 300 \times 0.573$

$V_x = 172$ m/s

$V_y = V_i \sin\theta$

$= 300 \sin 55°$

$= 245$ m/s

$X = 172 \times 42$

$X = 7224$

$Y = 245 \times 42 - \frac{1}{2}(9.8)(42)$

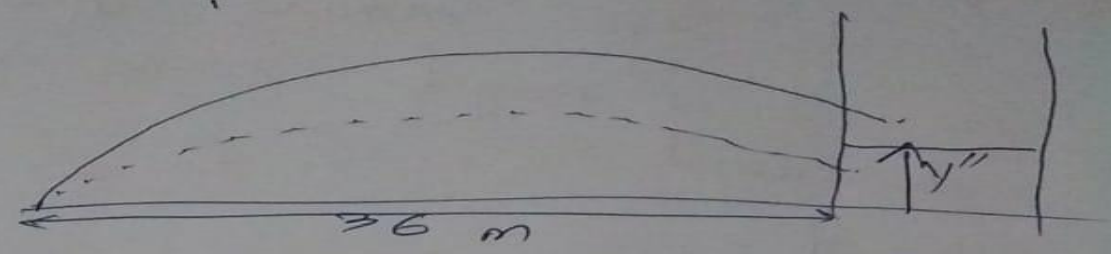
$= 10290 - 4.9 \times (42)^2$

$= 10290 - 8649$

$Y = 1646$

$(X, Y) = (7224, 1646)$

23.



DATA

$x = 36m$ $\quad y'' = 3.05$

$V_i = 20 m/sec$

$\theta = 53°$

REQUIRED.

$y' = ?$

Does it clear or not

FORMULA:

$$Y = x \tan\theta - \frac{g x^2}{2 V_i^2 \cos^2\theta}$$

SOLUTION

$$Y_f = (36\ m)(\tan 53) - \frac{(9.80)}{2(20)^2} \frac{x(36)^2}{\cos^2 53}$$

$$= 47.774 - 43.834 = 3.939$$

~~$Y_f = 0.889m$~~ $\quad y' = Y - y'' = 0.889m$

ball clear the bar

(b) The time ball takes to reach th max height.

$$t_1 = \frac{V_i \sin\theta_i - V_y}{g} = \frac{20 \times \sin 53 - 0}{9.8}$$

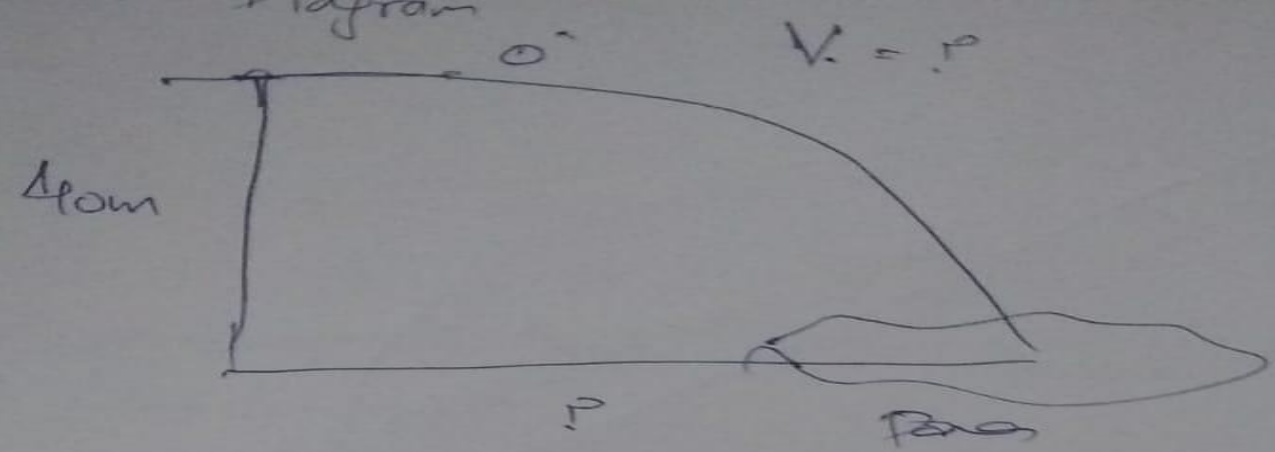
$$t_1 = 1.63\ s$$

The time to travel 36 m horizontally is

$$t_2 = \frac{X_f}{V_{xi}} = \frac{36m}{20 \times \cos 53} = 2.99.$$

$$t_2 > t_1$$

the ball is moving downward.



Data

H or D = 40 m

V_{sound} = 343 m/s

t_{sound} = 3 later

REQUIRED

V_i = ?

time to reach the ground =

FORMULA:

$$Y = V_i \sin\theta - \frac{1}{2} g t^2$$

$$-40 = 0 - \frac{1}{2} 9.8 t^2$$

$$\sqrt{\frac{-80}{9.8}} = \sqrt{t^2}$$

t = 2.85 sec

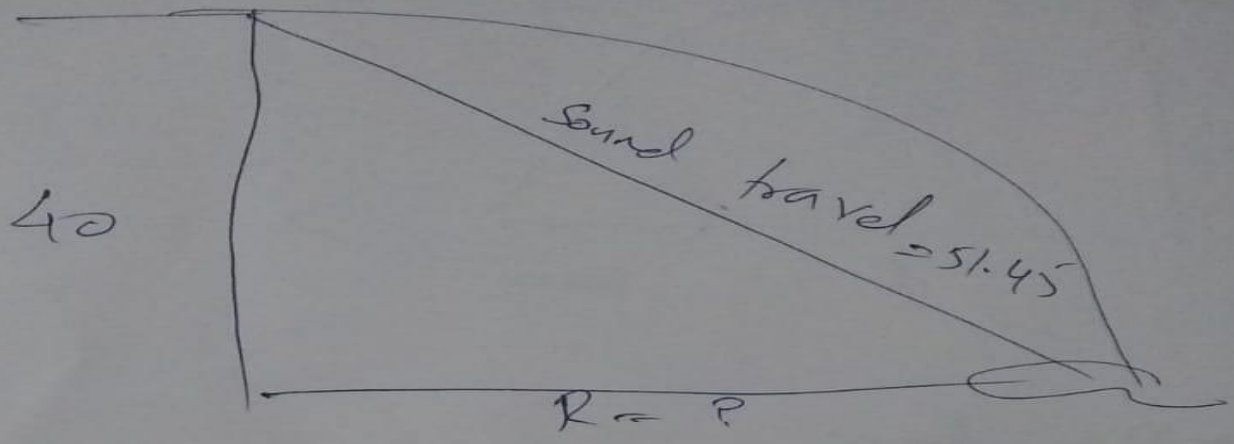
time the sound rea
the air

$t' = t_{sound} - t$

$= 3 - 2.85$

$t' = 0.15$ s

again



$S_{sound} = 343 \times 0.15$

$= 51.45$

$R^2 = (51.45)^2 - (40)^2$

$\sqrt{R^2} = \sqrt{1047.102}$

$R = 32.35$

$V. \cos\theta \, t = R$

$V. = \frac{R}{\cos\theta \, t} = \frac{32}{2.85}$

$V. = 11.22 \text{ m/}$