ACTIVITY

AIM

To study the variation in the range of a projectile with angle of projection.

MATERIAL REQUIRED

A constant level reservoir under pressure (a tap connected to a tank or water supply line), pipe with nozzle, measuring tape, ply board and protractor (radius = 30 cm).

THEORY

A particle or object projected at an angle with the horizontal surface with some initial velocity imparted to it, so that it then moves freely under gravity, is called projectile and such motion is called projectile motion. The path followed by a projectile is known as trajectory.

Equation of trajectory,

$$y = x\tan\theta - \frac{gx^2}{2u^2\cos\theta}$$

Maximum height of projectile,

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

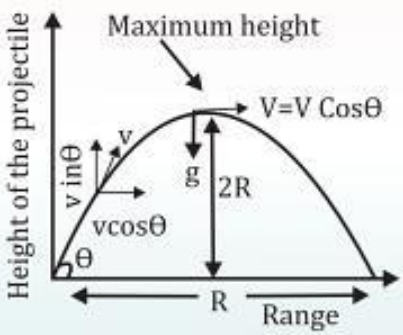
Horizontal range of projectile,

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

The range of projectile is exactly the same for two angles of projection θ and $(90 - \theta)$. For a given projection velocity, range will be the same for angle of projection θ, either with x-axis (horizontal direction) or with y-axis (vertical direction).

For, $\theta = 45°, \sin 2\theta = 1$, $R = \frac{u^2}{g}$ (when, $\theta = 45°$, range of projectile is the maximum).

Time of flight, $T = \frac{2u\sin\theta}{g}$



V (Velocity at time t)

V=V Cosθ(Horizontal component of V)

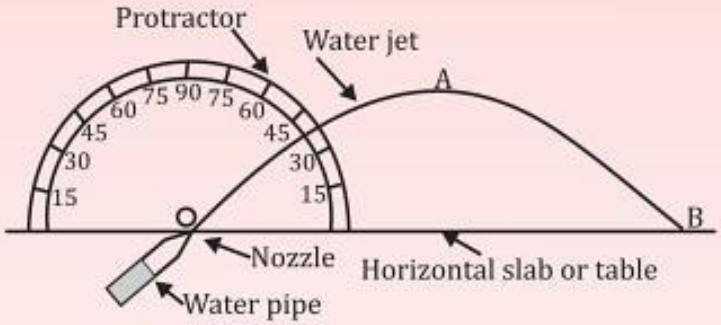
V Sinθ(Vertical component of V)

PROCEDURE

1. Connect one end of water pipe to the tap and fix the nozzle at its other end. Turn the tap on. Make sure

all connections are leakage free.

2. Place the nozzle bore in the centre of the protractor. Direct the stream of water a long line of the protractor.
3. Control the flow rate of water so that a steady stream comes out at moderate rate.
4. Let the water fall at some distance from the centre of the protractor. Mark the point where the stream strikes the ground.
5. Repeat step 4 for angles 30°, 45°, 60° and 75° and mark the points at which stream strikes the ground in each case. Label all five points as A, B, C, D and E and respectively. Label centre of protractor as O.
6. Measure the lengths of OA, OB, OC, OD, OE using a measuring tape.



Range of a Water jet

OBSERVATIONS

Least count of measuring tape = _____ cm.

Tabulate the observations as given below:

S. No.	Angle of projection (θ)	Range (R) (m)
1.	15°	
2.	30°	
3.	45°	
4.	60°	
5.	75°	

RESULT

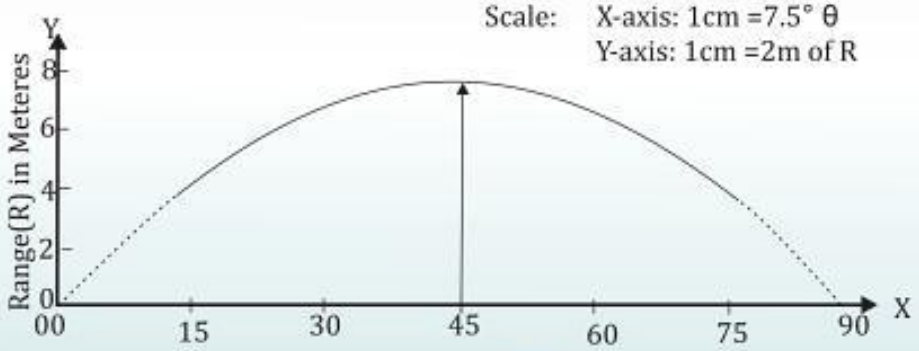
A graph is plotted by taking 'θ' on x-axis and range on y-axis.

The graph shows that initially, θ increases and 'R' increases along with it. Range is maximum for θ = 45°. When θ is further increased, range again decreases.

Graph between angle of inclination and range

Scale: X-axis: 1cm =7.5° θ

Y-axis: 1cm =2m of R



PRECAUTIONS

1. Water pressure must be kept constant.
2. Experiments should be performed in some open space.
3. The protractor should be held vertical, i.e., perpendicular to the ground.
4. The mouth of jet should be exactly at the center 'O' of protractor.

SOURCES OF ERROR

1. Water pressure may not be constant.
2. Stream may strike the ground water at a thick area and not a single point.

VIVA VOCE

Q1. What do you mean by a projectile?

Ans. A particle or object projected at an angle with the horizontal surface with some initial velocity imparted to it, so that it then moves freely under gravity, is called projectile and such motion is called projectile motion. The path followed by a projectile is known as trajectory.

Q2. State the formula for range of a projectile when is the range maximum for a given initial velocity?

Ans. Range $= \frac{u^2 \sin 2\theta}{g}$, range is maximum for $\theta = 45°$, as $\sin 90° = 1$.

Q3. Why do we aim the bullet slightly above the target while firing?

Ans. Bullet travels in projectile motion. So, it always hits slightly below the aimed target.

Q4. What is the shape of trajectory of projectile motion of a body?

Ans. Parabolic shape.

Q5. On the graph, which angles of projection have same range and how are they related?

Ans. Angles (θ) and $(90 - \theta)$ will have the same range, because $\sin \theta = \sin^2(90 - \theta)$.