

To Study the Variation in Range of a Projectile with Angle of Projection

Aim

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

Apparatus

A plywood protractor with radius of about 30 cm and marked 0° to 90° with an interval of 15° each, a 10-metre long measuring tape, A constant level reservoir under pressure (a tap connected to a tank or water supply line), a water pipe with a metallic nozzle (narrow opening).

Theory

The horizontal distances between point of projection and point of return, covered by the projectile during its flight, is called its horizontal range. It is represented by the symbol R .

If the water jet leaves the nozzle with a velocity U at an angle θ with horizontal, then the

$$\text{horizontal range } R = \frac{U^2 \sin 2\theta}{g}.$$

Diagram

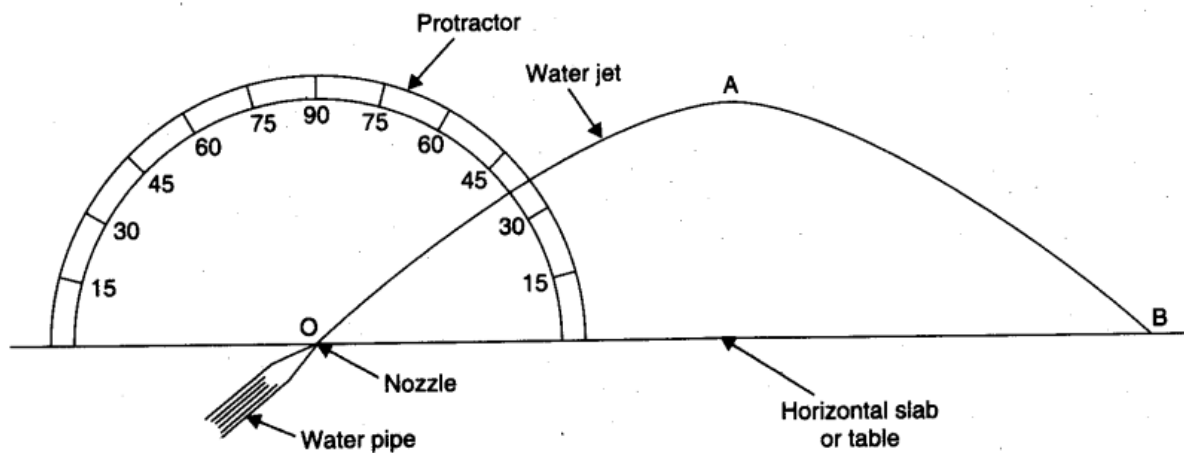


Fig. Range of a water jet.

Procedure

1. Arrange a constant level water reservoir at one end of a horizontal slab of the laboratory.

2. Connect a water pipe with the outlet of the reservoir and insert a metallic nozzle in the other end of the pipe held in hand.
3. Open the water tap and check that there is no leakage of water (remove if it is there).
4. Fix the protractor in a slot in a horizontal base to make its plane vertical and graduated surface towards yourself.
5. Place the nozzle at the centre O of the protractor and make the jet pass through 15° marking on it.
6. The jet moves along a parabola and falls back on the slab at some distance.
7. Set the water tap such that the distance is few metres.
8. Ask your laboratory bearer to make a mark B_1 on the slab where the jet falls.
9. Change the angle to 30° , 45° , 60° and 75° and repeat step 8 to get marks B_2 , B_3 , B_4 and B_5 .
(Do not change setting of water tap, otherwise it will change velocity U of the jet).
10. Measure distances OB_1 , OB_2 , OB_3 , OB_4 and OB_5 by the measuring tape. These distances give range R for different angles (and same velocity).
11. Record your observations in the table as given below.

Observations

Least count of measuring tape = 2 cm.

Table for angle and range

<i>Serial No. of Obs.</i>	<i>Angle of projection of water jet θ (degree)</i>	<i>Range of water jet R (m)</i>
1.	15°	$OB_1 =$
2.	30°	$OB_2 =$
3.	45°	$OB_3 =$
4.	60°	$OB_4 =$
5.	75°	$OB_5 =$

Graph

Plot a graph between angle θ and range R taking θ along X-axis and R along Y-axis.

The graph comes as shown below.

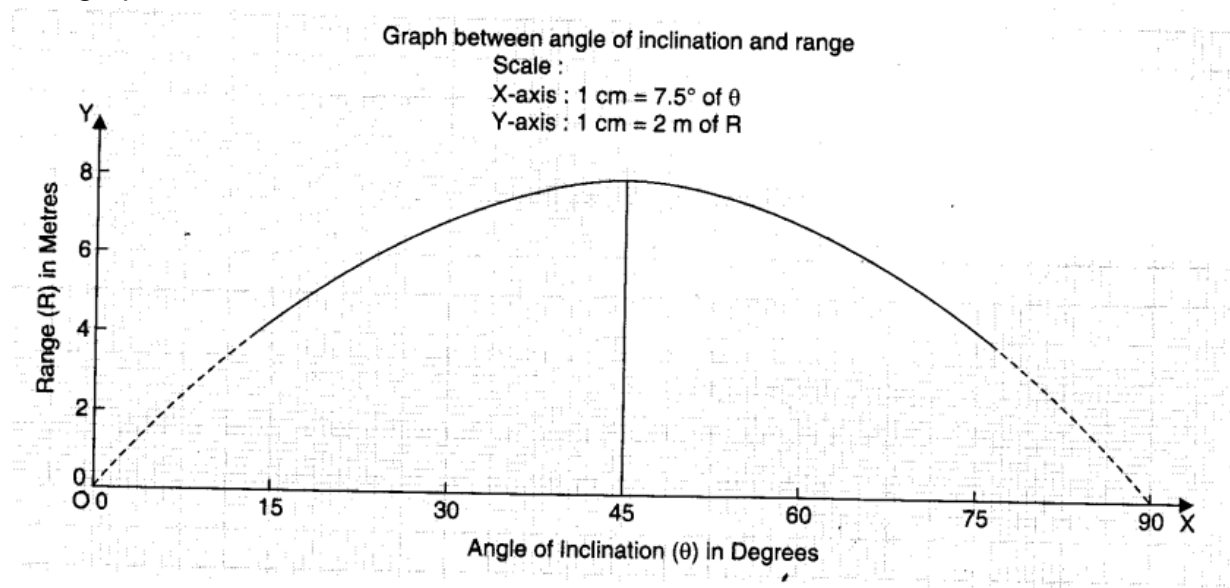


Fig. Graph between angle of inclination and range.

Result

From graph, we find the following two results :

1. Range is same for two complementary angles (i.e., 15° and 75° or 30° and 60°).
2. Range is maximum for angle of projection of 45°.

Precautions

1. Water level in reservoir should remain constant to keep velocity of projection constant.
2. Jet should be thin to get a sharp point of return.

Sources of error

1. Velocity of water jet may change during experiment.
2. Point of return may not be sharp.