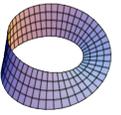
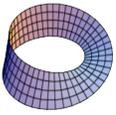


## Projectiles – Further Projectiles

1. \* A particle is projected with a speed of 98 m/s at an angle  $\alpha$  to the horizontal. The range is 940.8 m. Find
  - (i) the two values of  $\alpha$
  - (ii) the difference between the two times of flight.
2. \* A particle is projected from a point P on horizontal ground. The speed of projection is 35 m/s at an angle  $\tan^{-1} 2$  to the horizontal. The particle strikes a target whose position vector relative to P is  $x\vec{i} + 50\vec{j}$ .
  - (i) the value of  $x$ .
  - (ii) a second possible angle of projection.
3. \* In a room of height 6 m, a ball is projected from a point P. P is 1.1 m above the floor. The velocity of projection is  $9.8\sqrt{2}$  m/s at an angle of  $45^\circ$  to the horizontal. The ball strikes the ceiling at Q without first striking a wall. Find the length of the straight line PQ.
4. \* A straight vertical cliff is 200 m high. A particle is projected from the top of the cliff. The speed of projection is  $14\sqrt{10}$  m/s at an angle  $\alpha$  to the horizontal. The particle strikes the level ground at a distance of 200 m from the foot of the cliff.
  - (i) Find, in terms of  $\alpha$ , the time taken for the particle to hit the ground.
  - (ii) Show that the two possible directions of projection are at right angles to each other.
5. \* A ball is projected from a point on the ground a distance  $a$  from the foot of a vertical wall (height  $b$ ). The initial velocity is  $u$  at an angle  $45^\circ$  to the horizontal. If the ball just clears the wall prove that the max height is  $\frac{a^2}{4(a-b)}$ .
6. \* A particle is projected with a speed of  $7\sqrt{5}$  m/s at an angle  $\alpha$  to the horizontal. Find the two values of  $\alpha$  that will give a range of 12.5 m.
7. \* A particle is projected from a point o with velocity  $9.8\vec{i} + 29.4\vec{j}$  m/s where  $\vec{i}$  and  $\vec{j}$  are unit perpendicular vectors in the horizontal and vertical directions, respectively.
  - (i) Express the velocity of the particle after  $t$  seconds in terms of  $\vec{i}$  and  $\vec{j}$ .
  - (ii) Express the displacement of the particle after  $t$  seconds in terms of  $\vec{i}$  and  $\vec{j}$ .
  - (iii) Find, in terms of  $t$ , the direction in which the particle is moving after  $t$  seconds.
  - (iv) Find the two times when the direction of the particle is at right angles to the line joining the particle to o.
8. \* A ball is projected horizontally from a point q above a smooth horizontal plane with speed 2 m/s. The ball first hits the plane at a point whose horizontal displacement from q is 0.4 m. The ball next strikes the plane at a horizontal displacement of 1 m from q. The coefficient of restitution between the ball and the plane is  $e$ . Find the value of  $e$ .
9. \* A particle is projected from a point on the horizontal floor of a tunnel with maximum height of 8 m. The particle is projected with an initial speed of 20 m/s inclined at an angle  $\alpha$  to the horizontal floor. Find, to the nearest metre, the greatest range which can be attained in the tunnel.
10. \* A particle is projected from a point on level horizontal ground at an angle  $\theta$  to the horizontal ground. Find  $\theta$ , if the horizontal range of the particle is five times the maximum height reached by the particle.



## Source(s):

- <http://www.MathsGrinds.ie/>
- <http://www.examinations.ie/>

## Further Information:

- Questions marked with an asterisk \* are past Leaving Cert Exam questions.

## Answers:

- (i)  $36.87^\circ$  or  $53.13^\circ$   
(ii) 4 s
- (i) 50  
(ii)  $71.6^\circ$
- 10.96 m
- (i)  $\frac{200}{14\sqrt{10}\cos\alpha}$   
(ii) N/A
- N/A
- $15^\circ$  or  $75^\circ$
- (i)  $9.8\vec{i} + (29.4 - gt)\vec{j}$   
(ii)  $9.8t\vec{i} + (29.4t - \frac{1}{2}gt^2)\vec{j}$   
(iii)  $\tan^{-1}(3 - t)$   
(iv) 4 or 5 s
- $\frac{3}{4}$
- 40 m
- $38.7^\circ$