

Chapter 4: 2-D Motion

1. A projectile is fired from the surface of level ground at an angle ϕ about the horizontal. Show that the elevation angle θ of the highest point as seen from the launch point is related to ϕ by $\tan \theta = \frac{1}{2} \tan \phi$.
2. Car A moves along the line $y = 30$ m with a constant velocity of magnitude 3 m/s and parallel to x axis. At the instant car A passes the y axis, car B leaves the origin with a zero initial speed and a constant acceleration of magnitude 0.4 m/s^2 . What angle θ between a and the positive direction of the y axis would result in a collision?
3. Given the initial firing angle θ of a projectile, find the launch speed V , such that the projectile just hits the other side of the ravine a horizontal distance away of D .
4. Jeeps P and B race along straight lines, across flat terrain, and past stationary border guard A. Relative to the guard, B travels at a constant speed of $V = 5 \text{ m/s}$ at the angle θ_2 , P accelerates from rest at a constant rate of $a = 2 \text{ m/s}^2$ at the angle θ_1 . At time t , what are the (a) velocity of P relative to B, and (b) acceleration of P relative to B?
5. Car A is traveling north at 20 m/s crosses the intersection, at the instant car B starts from rest 50 m east of the intersection and moves west with a constant acceleration of 2 m/s^2 . t seconds after A crosses the intersection, find (a) the position of B relative to A, (b) the velocity of B relative to A, (c) the acceleration of B relative to A.
6. An object is projected horizontally with an initial velocity V at the top of a cliff of height H . Find the magnitude of the object's centripetal acceleration at the point in its trajectory halfway in time through its flight to the ground.
7. Two balls are thrown with equal speeds from the top of a cliff of height h . One ball is thrown at an angle of α above the horizontal. The other ball is thrown at an angle β below the horizontal. Show that each ball strikes the ground with the same speed, and find that speed in terms of h and the initial speed v_0 .
8. A rubber ball is dropped onto a ramp that is tilted at 20° . A bouncing ball obeys the "law of reflection", which says that the ball leaves the surface at the same angle it approached the surface. The ball's next bounce is 3.0 m to the right of its first bounce. What is the ball's rebound speed on its first bounce?

