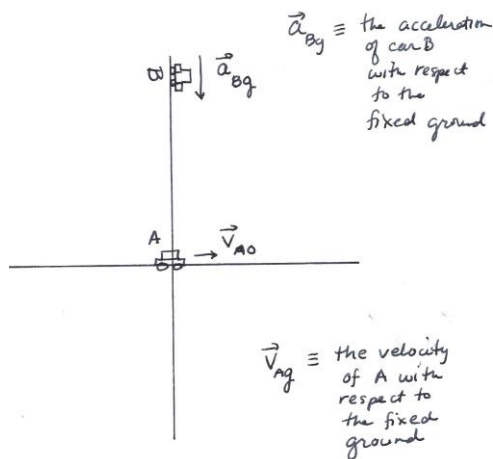


A two dimensional kinematics homework set 2.

- Find the angle such that the maximum height of a projectile is equal to its horizontal range.
- Car A is traveling east at 20 m/s. As car A crosses the intersection shown in the diagram, car B starts from rest 40m north of the intersection and moves south with a constant acceleration of 2 m/s².
 - What is the position of B relative to A 6 s after A crosses the intersection?
 - What is the velocity of B relative to A for t = 6 s?
 - What is the acceleration of B relative to A for t = 6 s?



- Derive a general formula for the horizontal distance covered by a projectile launched horizontally at speed v_0 from height h .
- A freight train is moving at a constant speed of V_t . A man standing on a flatcar throws a ball into the air and catches it as it falls. Relative to the flatcar, the initial velocity of the ball is V_{ib} straight up.
 - What are the magnitude and direction of the initial velocity of the ball as seen by a second man standing on the ground next to the track?
 - How much time is the ball in the air according to the man on the train? According to the man on the ground? Mathematically prove your two answers.
 - What horizontal distance has the ball traveled by the time it is caught according to the man on the train? According to the man on the ground?
 - What is the minimum speed of the ball during its flight according to the man on the train? According to the man on the ground?
 - What is the acceleration of the ball according to the man on the train? According to the man on the ground?

5. Galileo, in his *Two New Sciences*, states that "for elevations (angles of projection) which exceed or fall short of 45 degrees by equal amounts, the ranges are equal. Prove it.

6. A rifle with a muzzle velocity of V_0 shoots a bullet at a target R away at the level of the muzzle. How high above the target must the rifle be aimed so that the bullet will hit the target? (Neglect air resistance.)

Let $V_0 = 250$ m/s and $R = 100$ m. Find H

7. A bus with a vertical windshield moves along in a rainstorm at speed V relative to the ground. The raindrops fall vertically with a terminal speed of V' relative to the ground. At what angle do the raindrops strike the windshield?

8. A projectile launched at an angle " θ " to the horizontal reaches a maximum height h . Show that its horizontal range is $4h/\tan(\theta)$.

9. A jetliner with an airspeed of 1000 km/hr sets out on a 1500 km flight due south. To maintain a southward direction, however, the plane must be pointed fifteen degrees west of south. If the flight takes 100 min, what is the wind velocity?

10. If you can throw a stone straight up to a height of 16m, how far could you throw it horizontally over level ground? Assume the same throwing speed and optimum launch angle.

11. A hammer slides down a roof of angle θ (with respect to the ground). It slides along the roof distance D . As it leaves the roof, a height H above the ground, it has velocity in both directions. Find how far from the base of the building the hammer lands.
