2-D Motion

Jeremy Du, Victoria Tsai

October 6, 2015

1 2-D Motion

You guys are probably all pros at doing problems with numbers you can plug in, so let's do one without that.

1. Arnold launches a ball (consider the launch height to be the landing weight) with a launch angle of θ and a launch velocity of v_0. Find:

   (a) The maximum height reached by the ball.

   (b) The range of the ball (how far does it travel?)

   (c) From your first two answers, at what angle(s) would the ball have the highest height and/or range?

   The formulas for the height and range are sometimes useful.

2. Imagine a magical rectangular world of width d and infinite height. There is a horizontal bar also of width d that separates the top half of this world from the bottom half. Gravity goes towards the bar: Above the bar, gravity is down, but below the bar, gravity is up. When a projectile reaches the left wall at a height h above the bar, it will be transported to the right wall at the same height h below the bar, but retain the exact same velocity as before (if it was going left and up, it will continue to go left and up). For a projectile launched left upwards from on top of the bar at an angle θ above the horizontal and distance d_1 from the left wall, find the necessary conditions for the projectile in terms of h, d_1, d, and θ to end up at the exact same spot d_1 from the left wall.
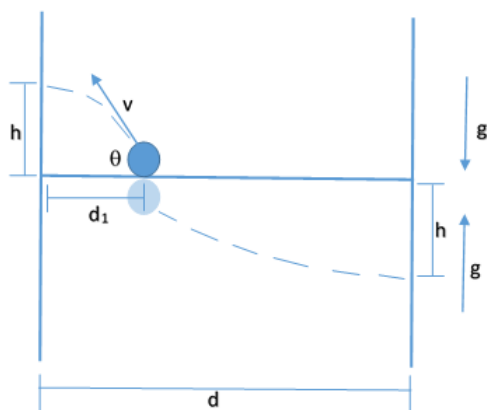

Figure 1: Problem 1 Setup

3. After Ed returns from yet another adventure with his fullmetal leg broken down and completely non-functional, Winry's patience reaches its limit. Ed is 37 meters from Winry's front door while Winry is standing on the fourth floor balcony 13 meters up and directly above her front door. If Ed starts running towards Winry's door at a constant rate of 2 meters per second (seeking shelter) and at the same time Winry throws her wrench at an astonishingly powerful 7 meters per second, find (a) the angle Winry must throw her wrench for it to connect with Ed's head 1.5 meters above the ground and (b) the amount of time it will take for Winry's wrench to hit Ed's head.
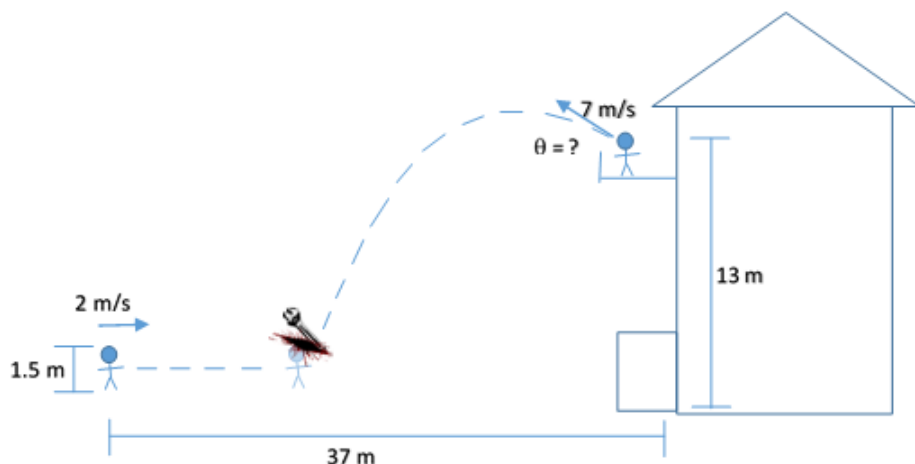

Figure 2: Problem 2 Setup

4. Quantitative: There is a well known demonstration that's called "The Monkey and the Hunter", but since we don't want to offend PETA let's call it "The Jeremy and the Arnold". Jeremy is hanging on a tree, when suddenly Arnold sees him and wants to shoot him down with his gun. The gun is really loud, so at the same instant Arnold fires, Jeremy lets go and starts falling down. If Arnold wants to hit Jeremy, should he:

- Aim above Jeremy?
- Aim directly at Jeremy?
- Aim below Jeremy?
- There isn't enough information (it depends on the bullet speed, height, gravity, etc.)?