

Warm Up: Objects in Free-Fall, Projectiles

Prof. Jordan C. Hanson

September 26, 2022

1 Memory

1. $y(t) = -\frac{1}{2}gt^2 + v_{i,y}t + y_i$... Vertical displacement.
2. $v_y(t) = -gt + v_{i,y}$... Vertical velocity.
3. $R = (v_i^2 \sin(2\theta))/g$... The range formula.

2 Objects in Free-Fall, Projectiles

1. Use the *second* equation in the Memory Bank to show that the total time spent in the air of a projectile launched from the origin is

$$T = \frac{2v_i \sin \theta}{g} \quad (1)$$

2. Suppose we have a device that, when launching a marble straight upwards ($\theta = 90$ degrees) from the origin, it produces a measured flight time of T . (a) What is v_i in terms of the other variables? (b) Suppose that we now aim that device at $\theta = 45$ degrees. Derive an algebraic expression for where it will land, that is, the range R . (c) If $T = 2$ seconds, and $g = 9.81 \text{ m s}^{-2}$, what is R ?¹

¹Hint: $T = 2v_i/g$, if we've done the derivation correctly. Use this to find the **general** result for the range, then plug in numbers.