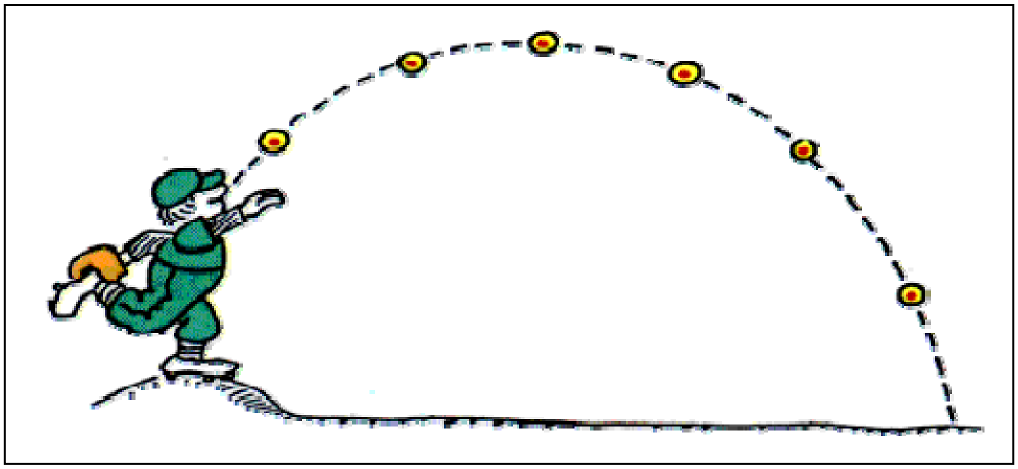

The horizontal motion of a rock (projectile) is given by the formula:

$$X = V_h T$$

Independently, the vertical motion is given by the formula

$$Y = H_0 + V_v T - \frac{1}{2} g T^2$$

The speed of the projectile has been described in terms of its vertical (Vv) and horizontal (Vh) speeds to that the total speed is given by the Pythagorean Theorem $S = (V_h^2 + V_v^2)^{1/2}$.

Problem 1 – A rock is tossed horizontally from the top of the Eiffel Tower at a speed of 60 mph (40 feet/sec). The Eiffel Tower stands 1,063 feet above the street. How far from the centerline of the tower does the rock land? ($g = 32$ feet/sec^2)

Problem 2 – On Mars ($g = 12$ feet/sec^2) an astronaut throws a rock up in the air so that its vertical speed is 30 feet/sec and its horizontal speed is 10 feet/sec. The rock starts at a shoulder height of 5 feet. How high does the rock travel, and how far from the astronaut does it finally reach the ground?

Problem 1 – A rock is tossed horizontally from the top of the Eiffel Tower at a speed of 60 mph (40 feet/sec). The Eiffel Tower stands 1,063 feet above the street. How far from the centerline of the tower does the rock land?

Answer: H_0 = 1063 feet, V_h = 40 feet/sec, V_v = 0.0, g = 32 feet/sec^2. The vertical equation give us the time to reach the ground (y=0) : 0 = 1063 – 16 T^2, so 1063/16 = T^2 and T = 8.1 seconds. From the horizontal motion, it travels d = 40 x 8.1 = **324 feet**.

Problem 2 – On Mars (g = 12 feet/sec^2) an astronaut throws a rock up in the air so that its vertical speed is 30 feet/sec and its horizontal speed is 10 feet/sec. The rock starts at a shoulder height of 5 feet. How high does the rock travel, and how far from the astronaut does it finally reach the ground?

Answer: The two equations are X = 10 T and $Y = 5.0 + 30T - 6T^2$

Write Y in terms of X: $Y = 5.0 + 30(X/10) - 6 (X/10)^2$ so $\mathbf{Y = 5.0 + 3.0X - 0.06X^2}$

Solve for the roots of $Y(X) = -0.06X^2 + 3.0X + 5.0$ with coefficients a = -0.06, b=3.0 and c = 5.0, to get the ground intercept points using the Quadratic Formula:

$X = [-3.0 +/- (9-4(-0.06)(5.0))^{1/2}] / (2x-0.06)$ so

X = (-3 + 3.19)/-0.12 = -1.6 feet , and the second root is

X = (-3 – 3.19)/-0.12 = +51.6 feet. see graph below.

The peak of the parabola is ½ way between the x-intercepts at x = (51.6-1.6)/2 = +25.0 feet And since X = 10T, we have 25 = 10T so T = 2.5 seconds. From Y(T), the altitude of the peak is $Y = 5.0 + 30(2.5) – 6(2.5)^2$ = **42.5 feet**. From the x-intercept, it reaches a distance of **51.6 feet from the astronaut.**