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Catapult Launch Data

The Second Amendment Air Cannon

Variables	Trial #1	Trial #2	Trial #3
PSI (launched at pounds per square inch)	60	70	80
Vi (initial velocity)	160.027 ft/sec	139.148 ft/sec	206.044 ft/sec
Vix (initial horizontal velocity)	116.5 ft/sec	101.3 ft/sec	150 ft/sec
Viy (initial vertical velocity)	109.485 ft/sec	95.177 ft/sec	140.934 ft/sec
total time	4.35 seconds	4.59 seconds	4.00 seconds
launch angle	43.2°	43.2°	43.2°
horizontal distance	507 feet	465 feet	600 feet
vertical distance (max height)	166.391 feet	138.159 feet	221.868 feet

Launch Angle Calculations

launch angle

$$tan\,(\theta) = \frac{O}{A}$$

$$tan^{-1}\,(tan\,(\theta)) = tan^{-1}\,(\frac{O}{A})$$

$$\theta = tan^{-1}\,(\frac{O}{A})$$

$$tan\,(\theta) = \frac{47\ inches}{50\ inches}$$

$$tan^{-1}\,(0.94) = tan^{-1}\,(\frac{47\ inches}{50\ inches})$$

$$\theta = tan^{-1}\,(\frac{47\ inches}{50\ inches})$$

$$\theta = 43.2°$$

Trial #1 Calculations

horizontal displacement $x(t) = Vix \cdot t$

given the horizontal distance $x(t) = 507\ feet$ and time $t = 4.35\ seconds$

$507\ ft = Vix \cdot 4.35\ seconds$

$\frac{507\ ft}{4.35} = Vix \cdot \frac{4.35\ seconds}{4.35}$

$Vix = 116.5\ ft/s$

initial horizontal velocity $Vix = Vi \cdot Cos(\theta)$

$116.5\ f/s = Vi \cdot cos(43.2)$

$116.5\ ft/s = Vi \cdot 0.728$

$\frac{116.5\ ft/s}{0.728} = Vi \cdot \frac{0.728}{0.728}$

$Vi = 160.027\ ft/s$

initial vertical velocity $Viy = Vi \cdot Sin(\theta)$

$Viy = 160.027 \cdot sin(43.2)$

$Viy = 160.027 \cdot 0.684$

$Viy = 109.458\ ft/s$

vertical displacement (max height) $y(t) = Viy \cdot \frac{t}{2} + 0.5\, g \frac{t}{2}^2 + y_0$

$y(t) = 109.458\ ft/s \cdot \frac{4.35\ seconds}{2} + 0.5(-32) \frac{4.35\ seconds}{2}^2 + 4\ ft$

$y(t) = 109.458\ ft/s \cdot 2.175 + (-16)\, 2.175^2 + 4\ ft$

$y(t) = 238.071 + (-16)\, 2.175^2 + 4\ ft$

$y(t) = 238.071 + (-16)\, 4.73 + 4\ ft$

$y(t) = 238.071 + -75.68 + 4\ ft$

$y(t) = 166.391\ ft$

Trial #2 Calculations

horizontal displacement $x(t) = Vix \cdot t$

given the horizontal distance $x(t) = 465\,feet$ and time $t = 4.59\,seconds$

$465\,ft = Vix \cdot 4.59\,seconds$

$\frac{465\,ft}{4.59} = Vix \cdot \frac{4.59\,seconds}{4.59}$

$Vix = 101.3\,ft/s$

initial horizontal velocity $Vix = Vi \cdot Cos(\theta)$

$101.3\,f/s = Vi \cdot cos(43.2)$

$101.3\,ft/s = Vi \cdot 0.728$

$\frac{101.3\,ft/s}{0.728} = Vi \cdot \frac{0.728}{0.728}$

$Vi = 139.148\,ft/s$

initial vertical velocity $Viy = Vi \cdot Sin(\theta)$

$Viy = 139.148 \cdot sin(43.2)$

$Viy = 139.148 \cdot 0.684$

$Viy = 95.177\,ft/s$

vertical displacement (max height) $y(t) = Viy \cdot \frac{t}{2} + 0.5\,g\frac{t}{2}^2 + y_0$

$y(t) = 95.177\,ft/s \cdot \frac{4.59\,seconds}{2} + 0.5\,(-32)\,\frac{4.59\,seconds}{2}^2 + 4\,ft$

$y(t) = 95.177\,ft/s \cdot 2.295 + (-16)\,2.295^2 + 4\,ft$

$y(t) = 218.431 + (-16)\,2.295^2 + 4\,ft$

$y(t) = 218.431 + (-16)\,5.267 + 4\,ft$

$y(t) = 218.431 + -84.272 + 4\,ft$

$y(t) = 138.159\,ft$

Trial #3 Calculations

horizontal displacement $x(t) = Vix \cdot t$

given the horizontal distance $x(t) = 600\,feet$ and time $t = 4.0\,seconds$

$600\,ft = Vix \cdot 4.0\,seconds$

$\frac{600\,ft}{4.0} = Vix \cdot \frac{4.0\,seconds}{4.0}$

$Vix = 150\,ft/s$

initial horizontal velocity $Vix = Vi \cdot Cos(\theta)$

$150\,f/s = Vi \cdot cos(43.2)$

$150\,ft/s = Vi \cdot 0.728$

$\frac{150\ ft/s}{0.728} = Vi \cdot \frac{0.728}{0.728}$

$Vi = 206.044\,ft/s$

initial vertical velocity $Viy = Vi \cdot Sin(\theta)$

$Viy = 206.044 \cdot sin(43.2)$

$Viy = 206.044 \cdot 0.684$

$Viy = 140.934\,ft/s$

vertical displacement (max height) $y(t) = Viy \cdot \frac{t}{2} + 0.5\,g\frac{t}{2}^2 + y_0$

$y(t) = 140.934\ ft/s \cdot \frac{4.0\,seconds}{2} + 0.5(-32)\frac{4.0\,seconds}{2}^2 + 4\,ft$

$y(t) = 140.934\,ft/s \cdot 2 + (-16)\,2^2 + 4\,ft$

$y(t) = 281.868 + (-16)\,2^2 + 4\,ft$

$y(t) = 281.868 + (-16)\,4 + 4\,ft$

$y(t) = 281.868 + -64 + 4\,ft$

$y(t) = 221.868\,ft$