The Human Cannonball, Ferris Wheels, and Trigonometry

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Zoom Meeting, June 2020

Slides and More Zoom Presentations: www.mckeague.com

Part 1: My Regular Conference Presentation for Instructors Teaching in a Classroom

Part 2: How to Adapt this Material to an Online Class

Five Minute Method

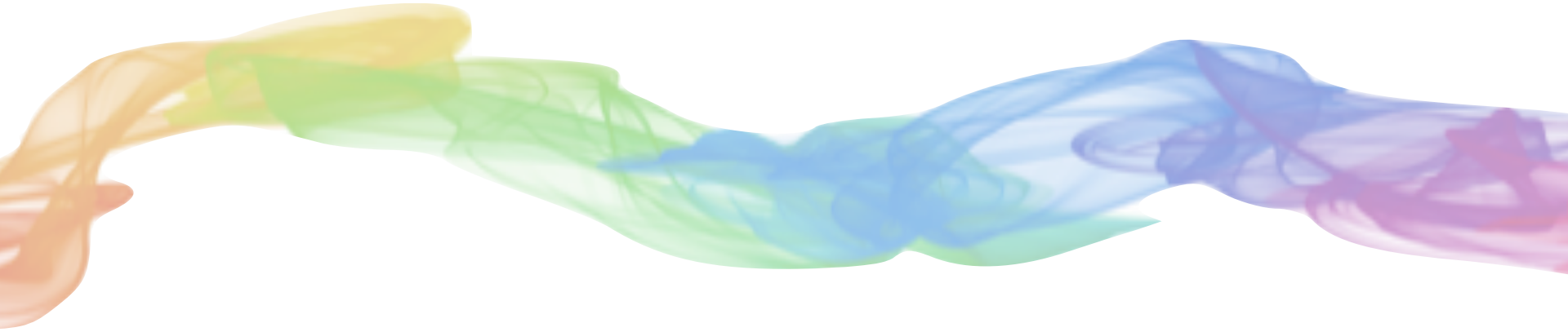
Take-Five! Reserve five minutes of each class session to bring in the things that I think are interesting in, and around, mathematics, and to accomplish my big goals.

Human Cannonball - Steele County Fair- My Favorite Minnesota

УЧИТЬСЯ РАБОТАТЬ И ЖИТЬ ПО-КОММУНИСТИЧЕСКИ!

3 КОП · ПОЧТА СССР · 1961

Chapter 1
Review of Graphing



Washington County

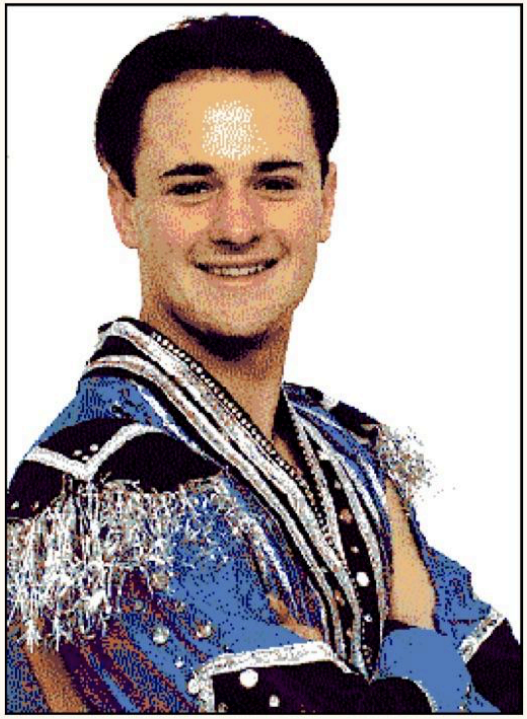
Oregon

1997 Fair & Rodeo:

Last Updated: July 23, 1997

Fair Complex
Cal Wade, Executive Director

down



Human Cannonball

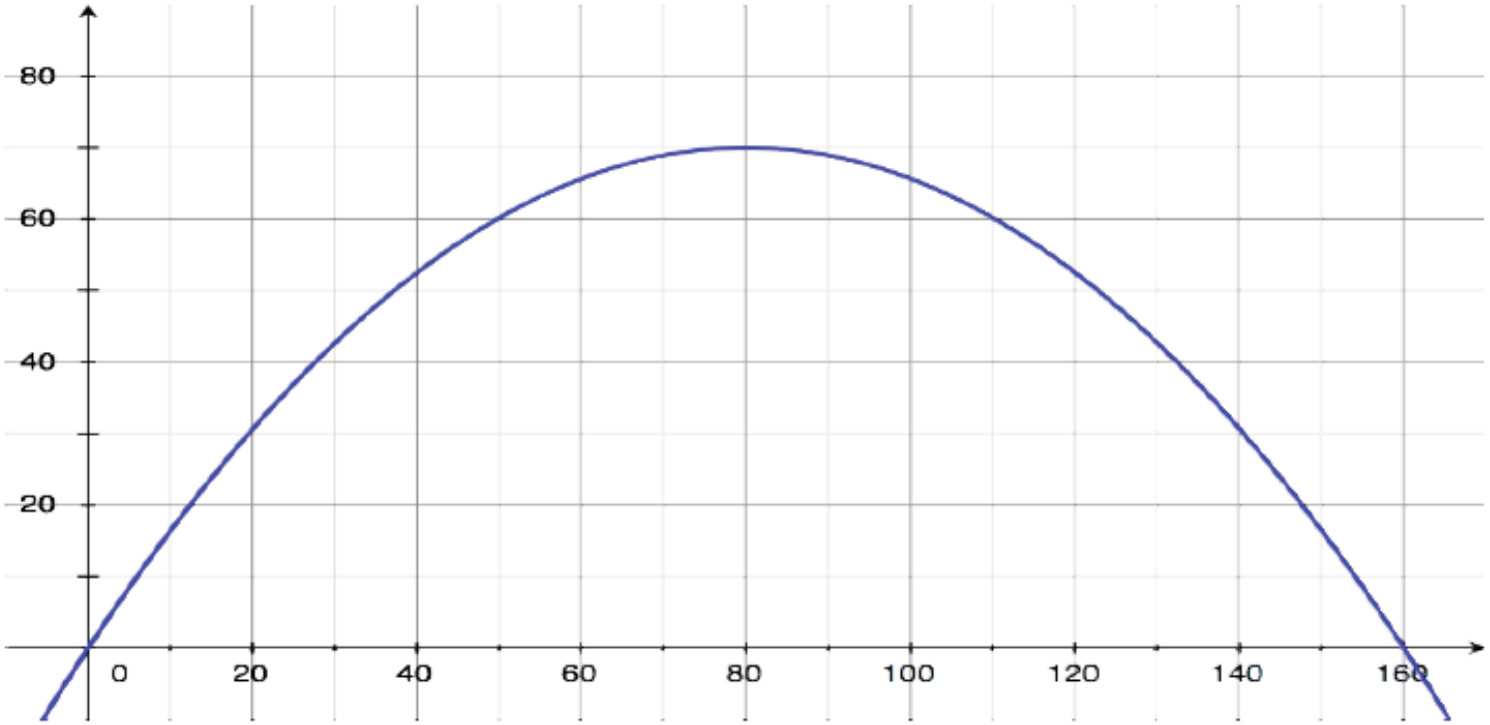
Tues-Fri, 3:30 & 8:00 PM 30
Sat, 12:30, 3:00 & 8:00 PM
Sun, 12:30, 3:30 & 6:30 PM

Cannonball Landing Site

As the countdown begins, David Smith, Jr. - THE BULLET, dons his safety helmet, slides down the slender barrel of his cannon positioning himself to become a human projectile. The crowd joins in the countdown and the announcer asks the audience to cover their ears as protection from the noise of the blast. Three! Two! One! FIRE! David Smith, Jr. - THE BULLET - blasts into the air, flies an average distance of 160 feet and a height of 60-70 feet and lands in his pre-positioned safety net. This is a death-defying feat guaranteed to send shivers down your spine!

The Bullet

Maximum Height: 70 feet Maximum distance: 160 feet

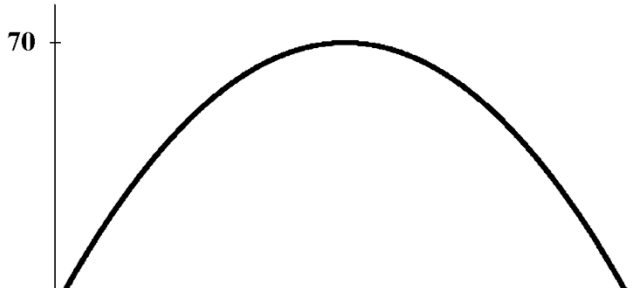


The curve is a parabola:

$$y = a(x-h)^2 + k \quad \text{for } 0 \le x \le 160$$

The Bullet

Maximum height: 70 feet Maximum distance: 160 feet



The curve is a parabola:

$$y = a(x-h)^2 + k \quad \text{for } 0 \le x \le 160$$

$$\text{Vertex: } (80,70) \quad \Rightarrow \quad y = a(x-80)^2 + 70$$

Starting point: (0, 0)

$$0 = a(0-80)^2 + 70$$

Ending point: (160, 0)

$$0 = a(160-80)^2 + 70$$

Either way

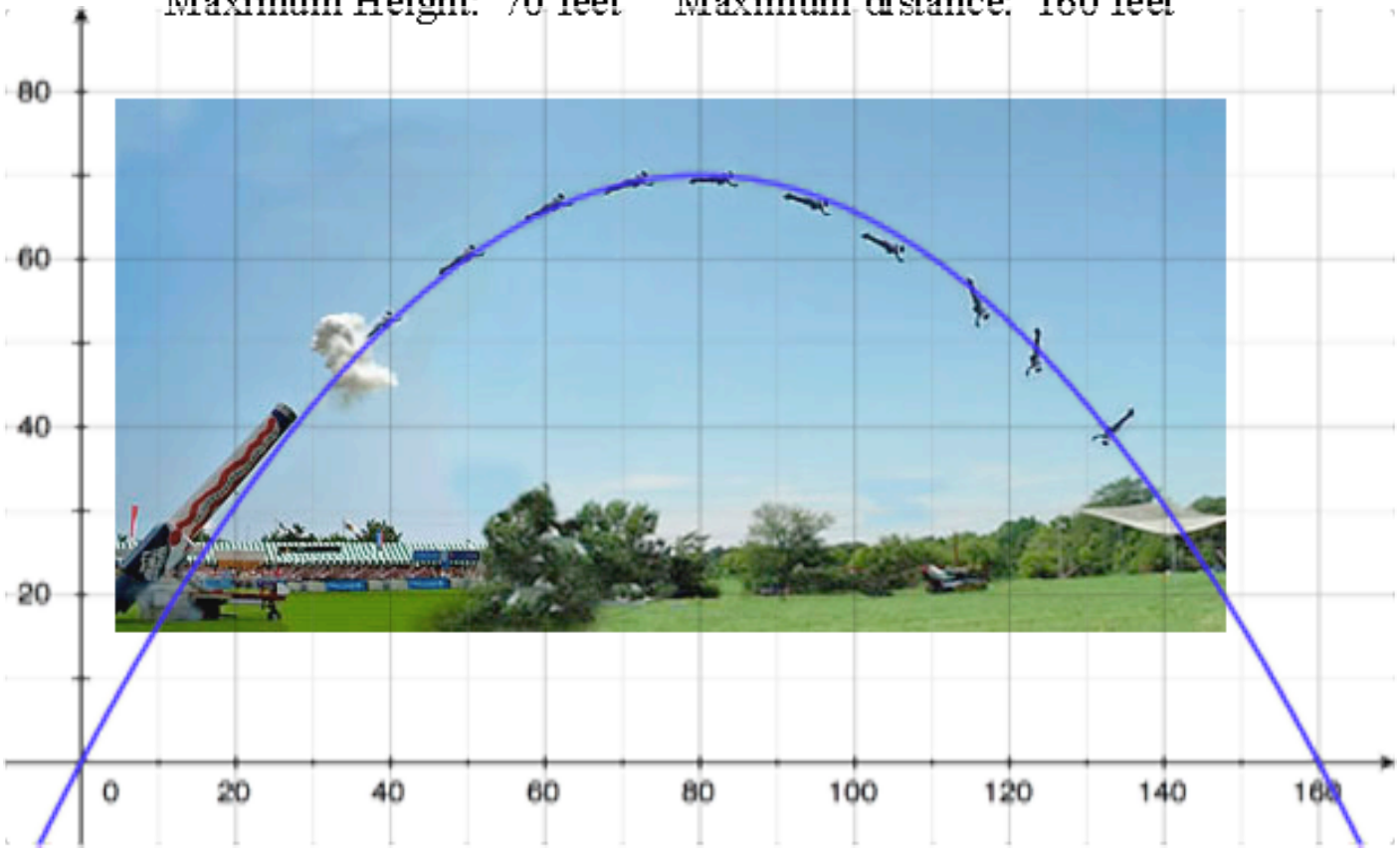
$$0 = 6400a + 70 \quad \Rightarrow \quad a = -\frac{70}{6400} = -\frac{7}{640}$$

Final Equation

$$y = -\frac{7}{640}(x-80)^2 + 70 \quad \text{for } 0 \le x \le 160$$

The Bullet

Maximum Height: 70 feet Maximum distance: 160 feet

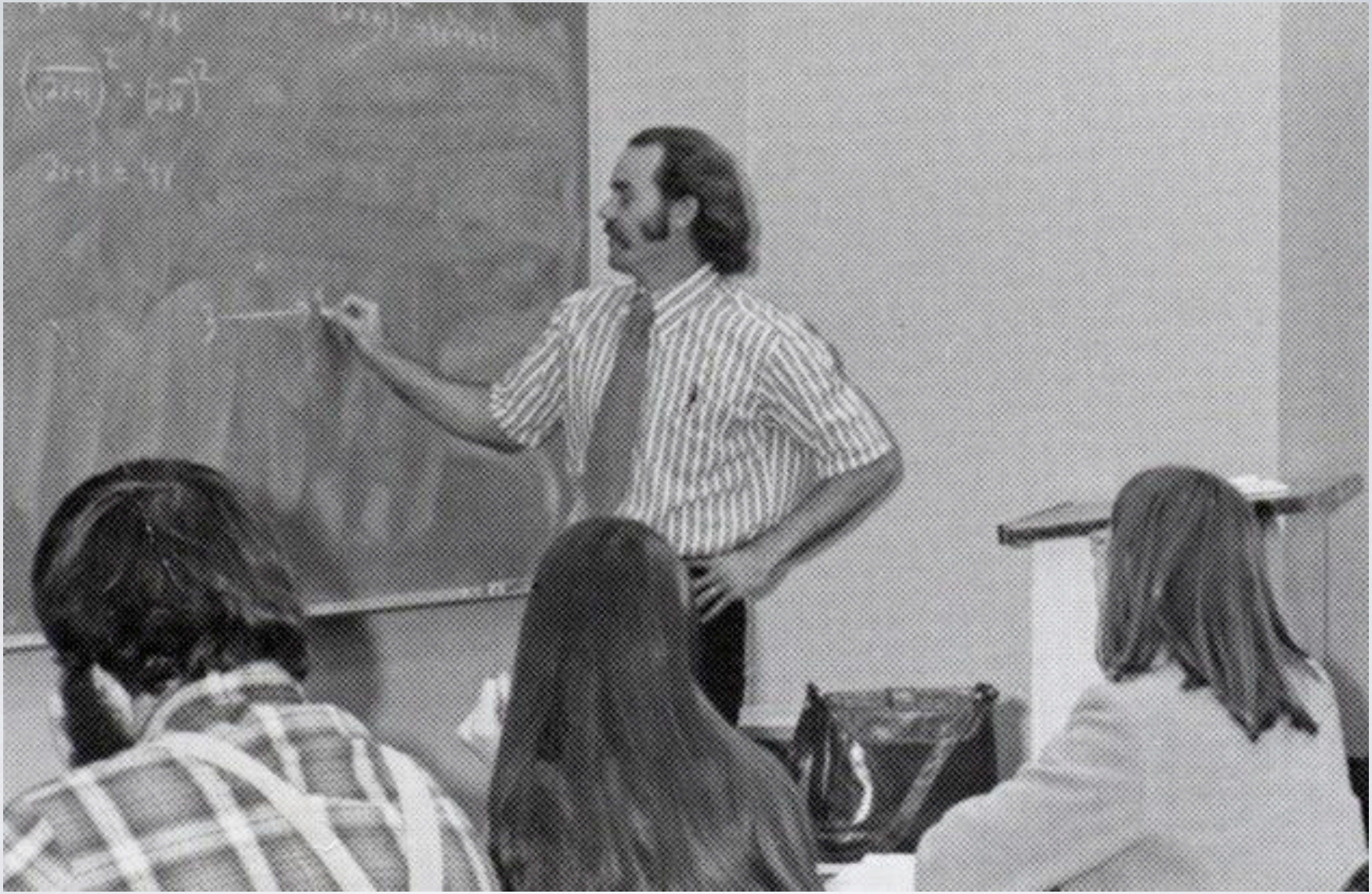


THE Great ZACCHINIS

History in Pictures

by Pat Ringling Buck

1944, Silvana is first female cannonball

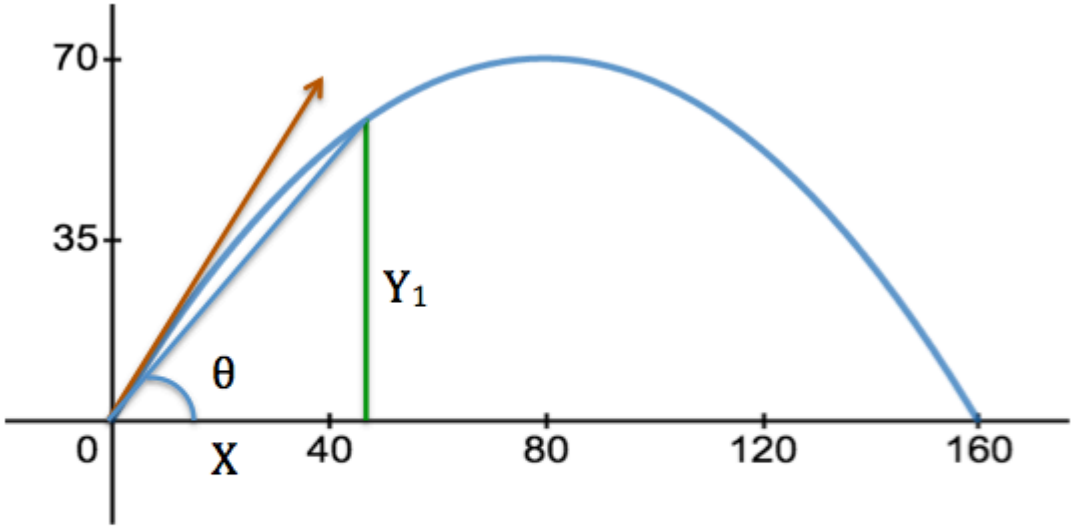


Cuesta College 1974

Chapter 2
Right Triangle Trigonometry

Which variables determine where the cannonball lands?

Find the Cannon Angle

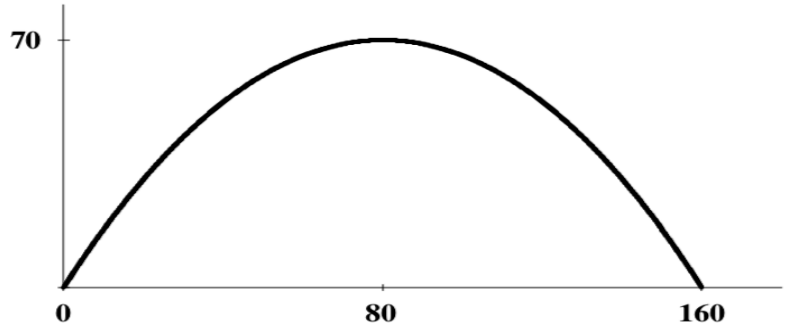


$$\theta = \tan^{-1}\left(\frac{Y_1}{X}\right)$$

The Bullet

Maximum height: 70 feet Maximum distance: 160 feet

Equation: $y = -\frac{7}{640}(x - 80)^2 + 70$ for $0 \le x \le 160$



What is the angle between the cannon and the horizontal?

Y Variables Setup

$Y1 = -\frac{7}{640}(X - 80)^2 + 70$

$Y2 = Y_1/X$

$Y3 = \tan^{-1}(Y_2)$

Table Setup

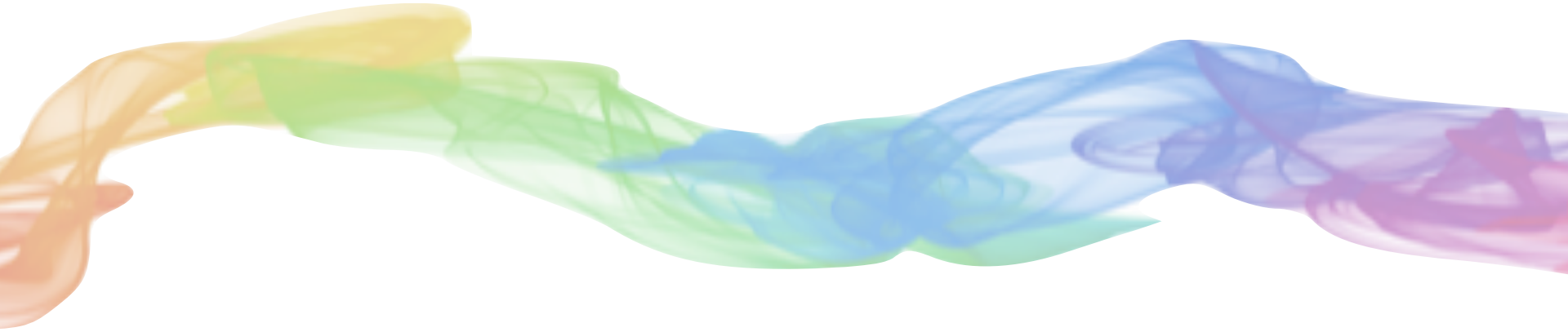
Start = 0.01

Increment = 0.01

Variables: Auto

x	y_3
1	60.100131
.5	60.177808
.1	60.239686
.01	60.253576
.001	60.254964
.0001	60.255103
.00001	60.255117

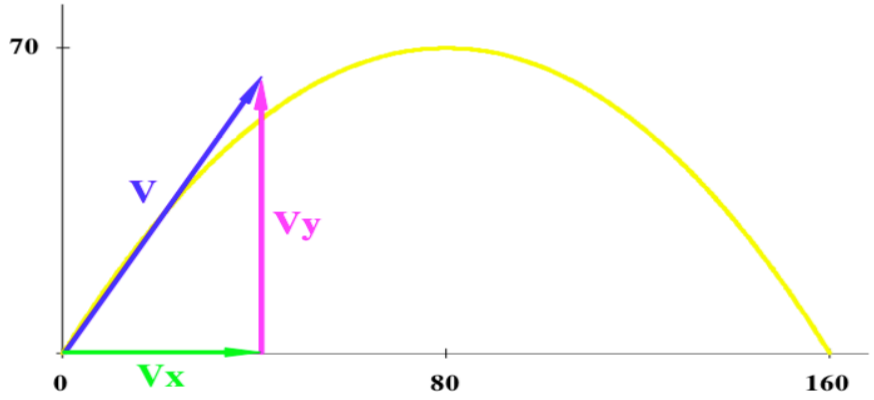
Chapter 2
Horizontal and Vertical Components of a Vector



The Bullet

Maximum height: 70 feet Maximum distance: 160 feet

Cannon angle: 60.3°



What is the initial velocity of The Bullet?

(First find the magnitude of V_y, its initial vertical speed.)

How long does it take for any object to fall 70 feet?

$$y = 16t^2$$
$$70 = 16t^2$$
$$t = \sqrt{\tfrac{70}{16}}$$
$$t \approx 2.092 \text{ seconds}$$

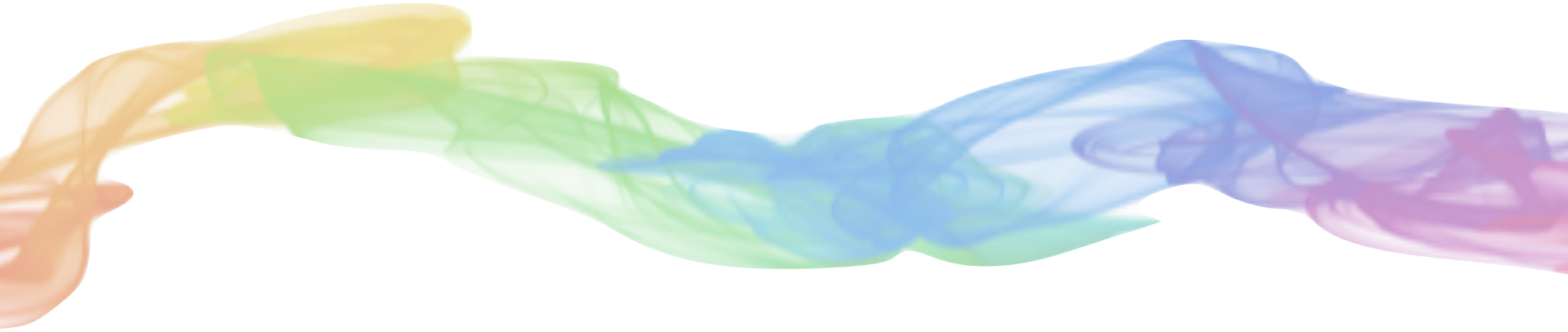
What is its speed when it hits the ground?

$$|V_y| = 32t$$
$$\approx 32(2.092)$$
$$= 66.94 \text{ ft/sec}$$

$$\sin 60.3° = \frac{66.94}{|V|} \quad \Rightarrow \quad |V| = \frac{66.94}{\sin 60.3°} = 77.0 \text{ ft/sec}$$

$$= 52.5 \text{ mi/hr}$$

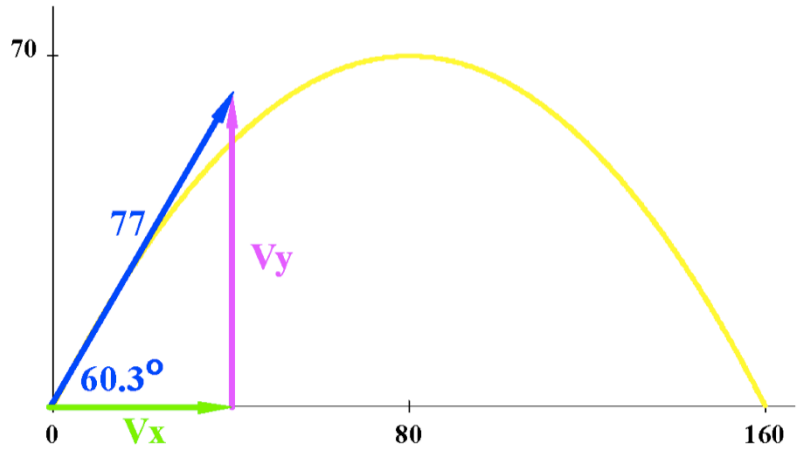
Chapter 6
Parametric Equations



The Bullet

Maximum height: 70 feet Maximum distance: 160 feet

Cannon angle: 60.3° Initial velocity: 52.5 mi/hr = 77 ft/sec



Can we write his position as a function of time?

$$\sin 60.3° = \frac{|V_y|}{77} \quad \Rightarrow \quad |V_y| = 77 \sin 60.3°$$

$$\cos 60.3° = \frac{|V_x|}{77} \quad \Rightarrow \quad |V_x| = 77 \cos 60.3°$$

$$d = r \cdot t$$

Horizontal distance: $x = (77\cos 60.3°)t$

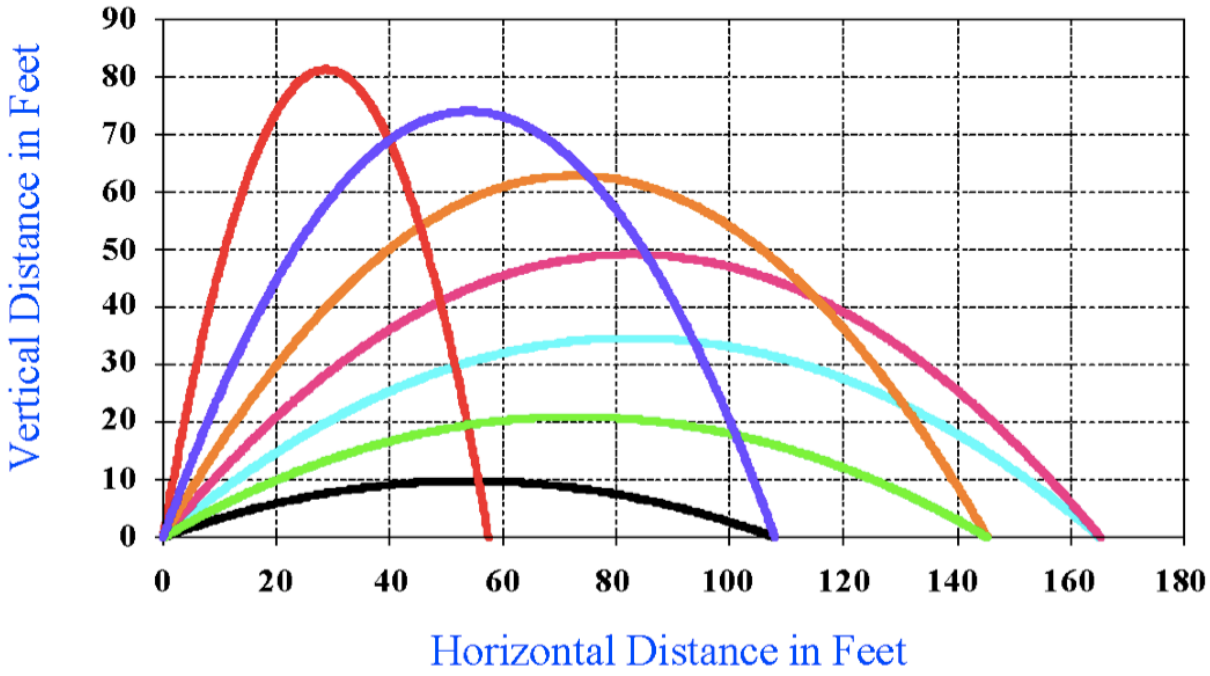
Vertical distance: $y =$ distance up $-$ distance down

$= (77\sin 60.3°)t - 16t^2$

Path of the Human Cannonball

Initial Velocity: 50 miles per hour

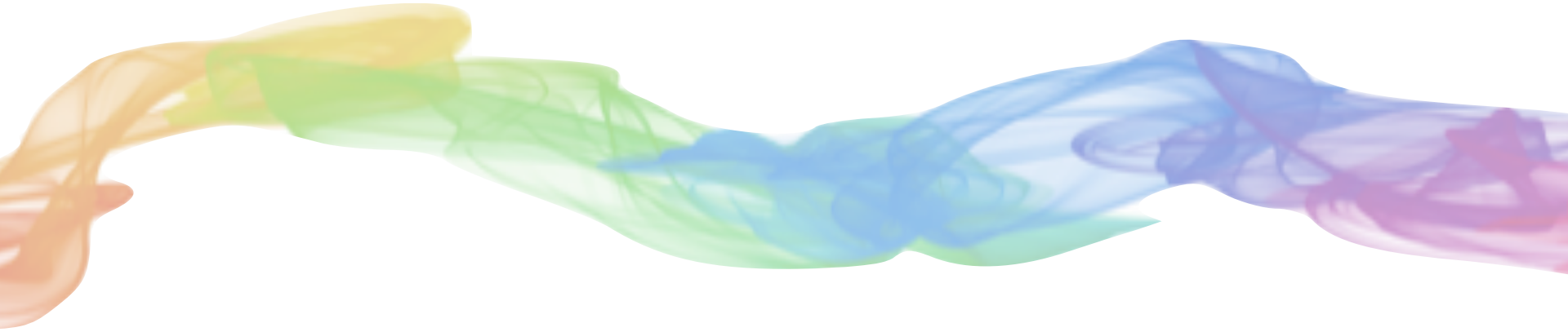
Angle: 20°, 30°, 40°, 50°, 60°, 70°, 80°



Minnesota County Fair

Photo by Susan Lambert Miller and published in book:
"Minnesota County Fairs" MHS Press, 2008.

Chapter 3
Linear and Angular Velocity



FERRIS WHEELS:

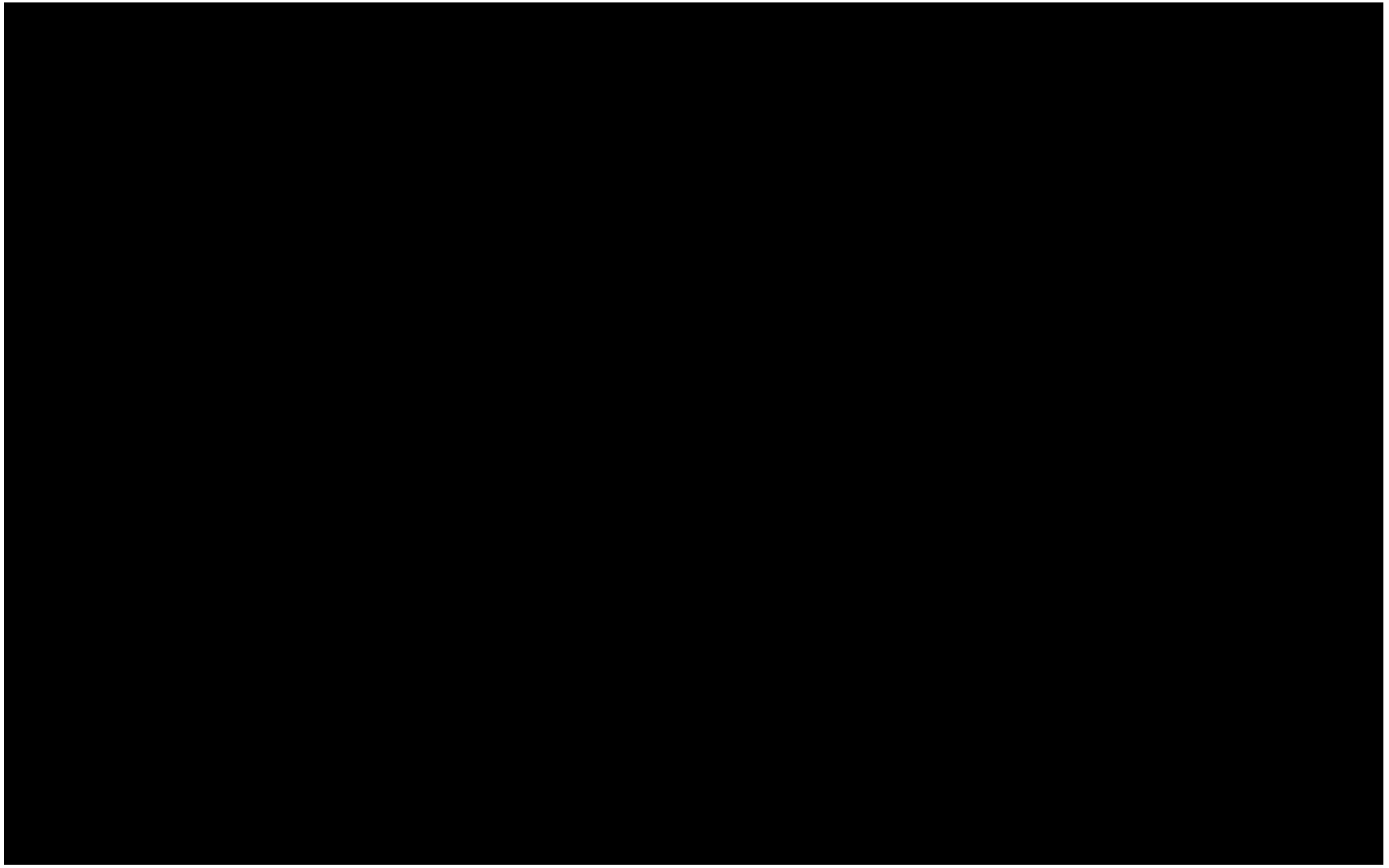
An Illustrated History

Norman Anderson

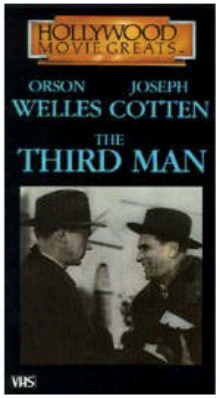
The Ferris Wheel
June 1893, Chicago

Diameter: 250 Feet
Top of wheel is 264 feet above the ground
36 carriages holding 60 people each
1 revolution every 20 minutes

The Riesenrad: The Giant Wheel in Vienna
Opened: 1897, 1 revolution 3.8 min, Diameter 197 feet



The Vienna Giant Ferris Wheel



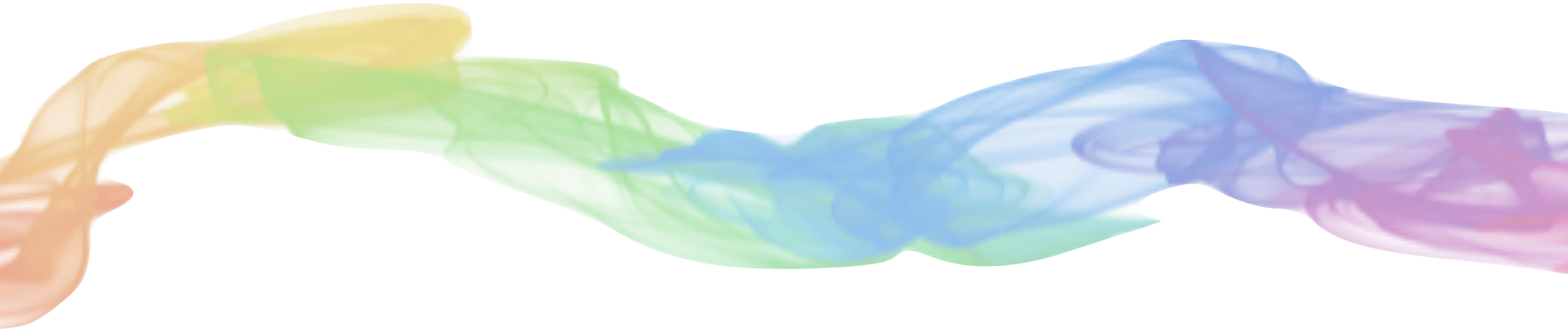
Velocities: From the movie *The Third Man*

$$\text{Angular: } \omega = \frac{2\pi \text{ radians}}{3.8 \text{ minutes}} = 1.65 \text{ radians/minute}$$

$$\text{Linear: } v = \frac{\pi(197 \text{ feet})}{3.8 \text{ minutes}} = 162.9 \text{ feet/minute}$$

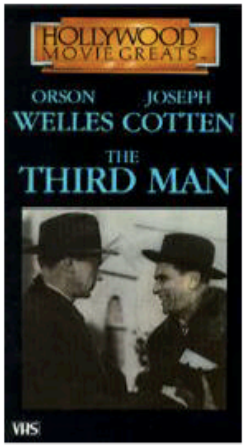
$$\frac{162.9 \text{ ft}}{1 \text{ min}} \cdot \frac{60 \text{ min}}{1 \text{ hr}} \cdot \frac{1 \text{ mi}}{5,280 \text{ ft}} = 1.85 \text{ miles/hour}$$

Chapter 6
Parametric Equations



To the Document Camera

The Vienna Giant Ferris Wheel



The path of *The Third Man:*

As a function of θ:

$$x = 98.5\cos(\theta - \tfrac{\pi}{2})$$
$$y = 98.5\sin(\theta - \tfrac{\pi}{2})$$

As a function of time: $\dfrac{\theta}{2\pi} = \dfrac{t}{3.8} \Rightarrow \theta = \dfrac{2\pi t}{3.8}$

$$x = 98.5\cos(\frac{2\pi t}{3.8} - \frac{\pi}{2})$$
$$y = 98.5\sin(\frac{2\pi t}{3.8} - \frac{\pi}{2})$$

The End