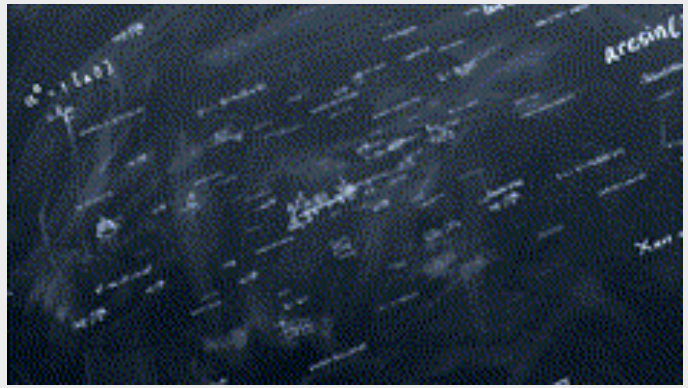
Motion in 2D

My website: https://scienceknowledge.webador.com/

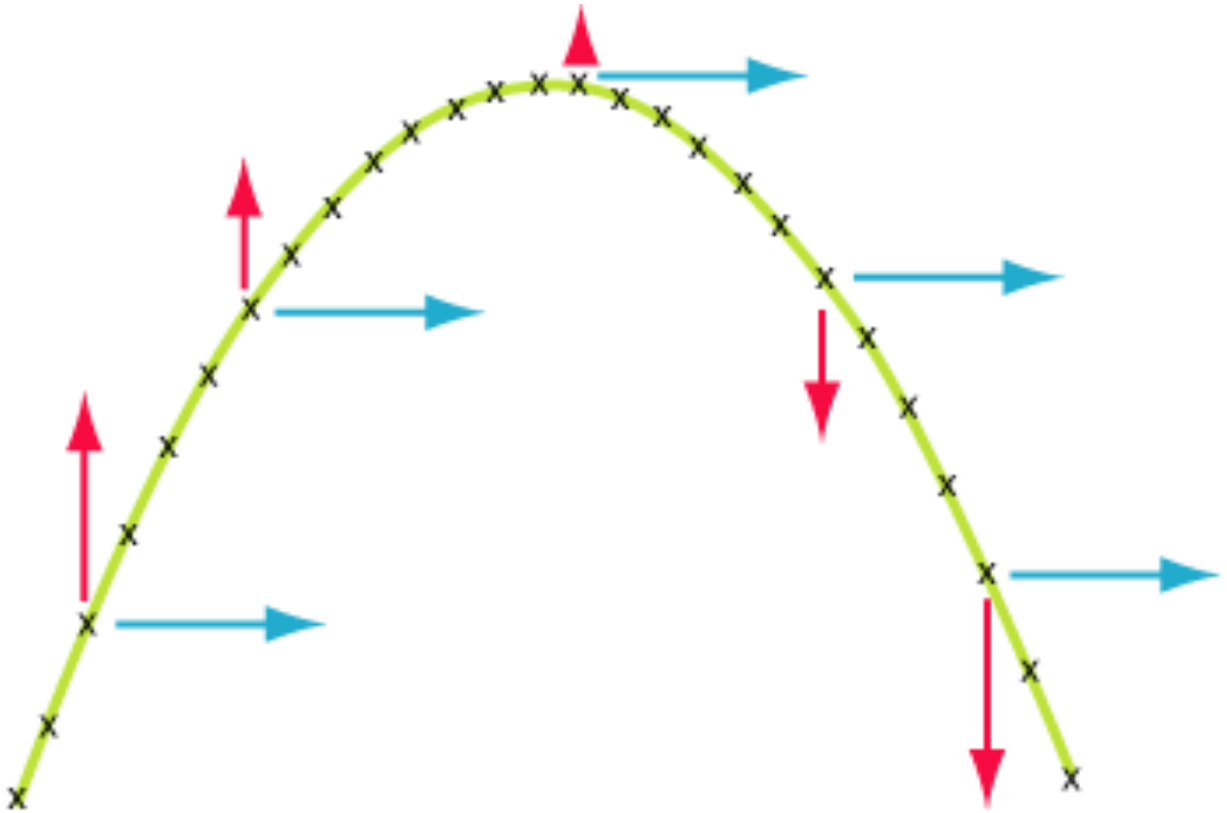


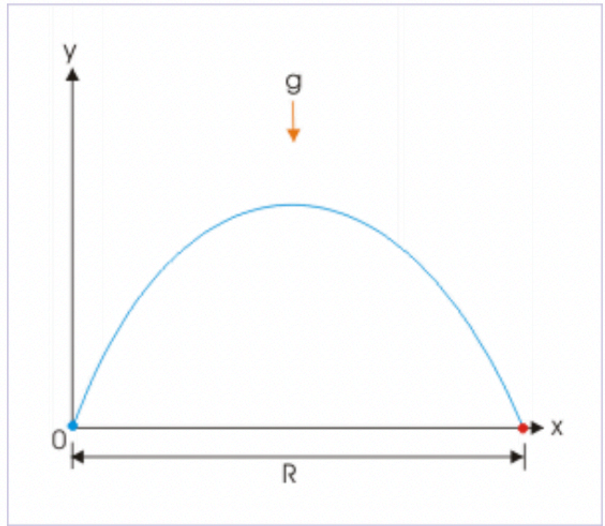
Learning Objectives

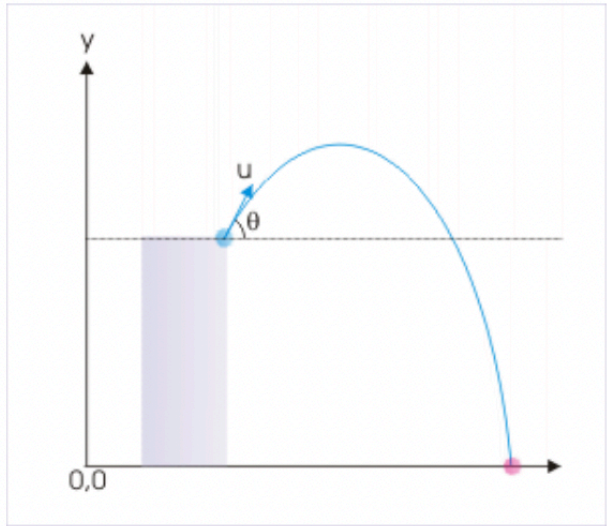
- Vector Components (Trigonometry)
- Kinematic Equations 2D
- Projectile Motion
- Motion in an inclined plane
- Relative Motion

Projectile Motion

- Projectile motion is a form of motion experienced by a launched object.
  - Affected by gravity only




y
g
0
x
R


y
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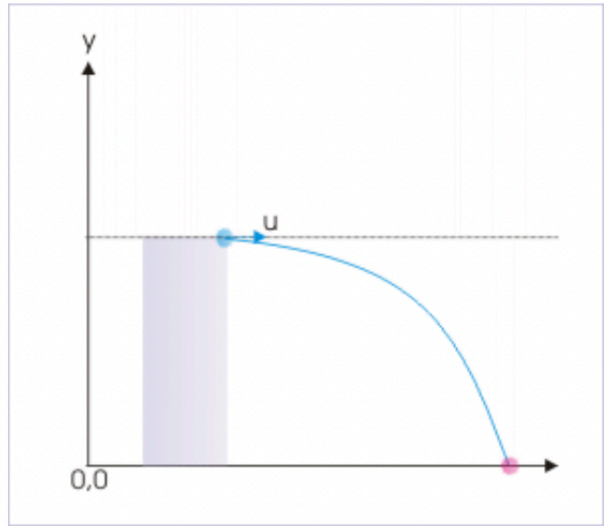
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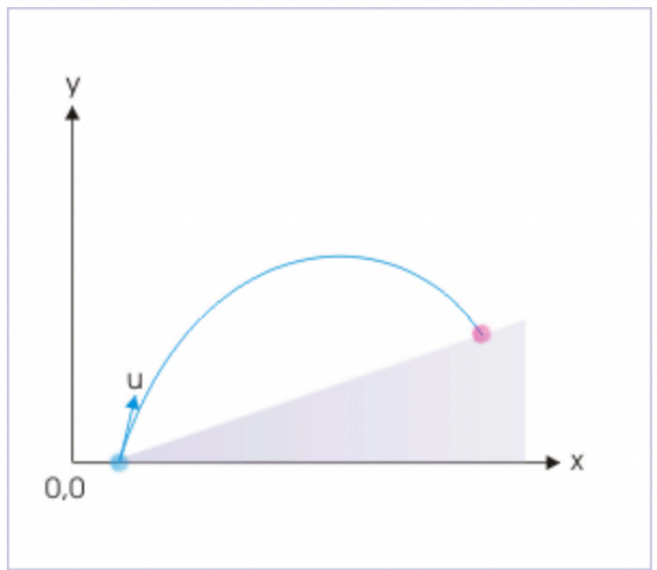
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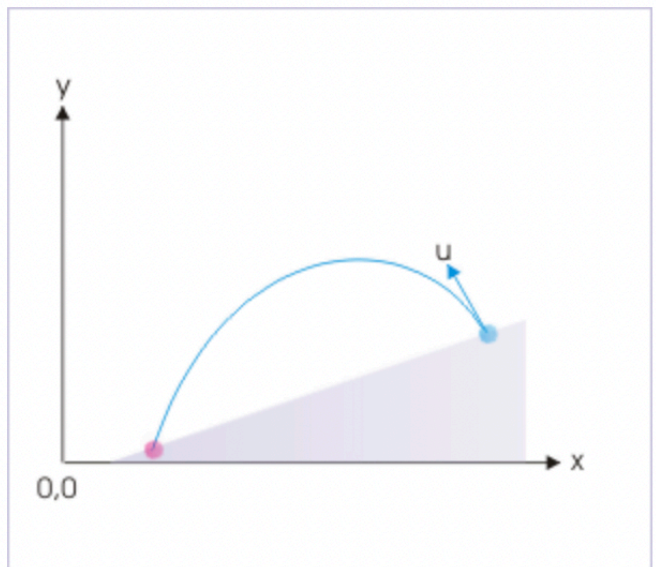
y
u
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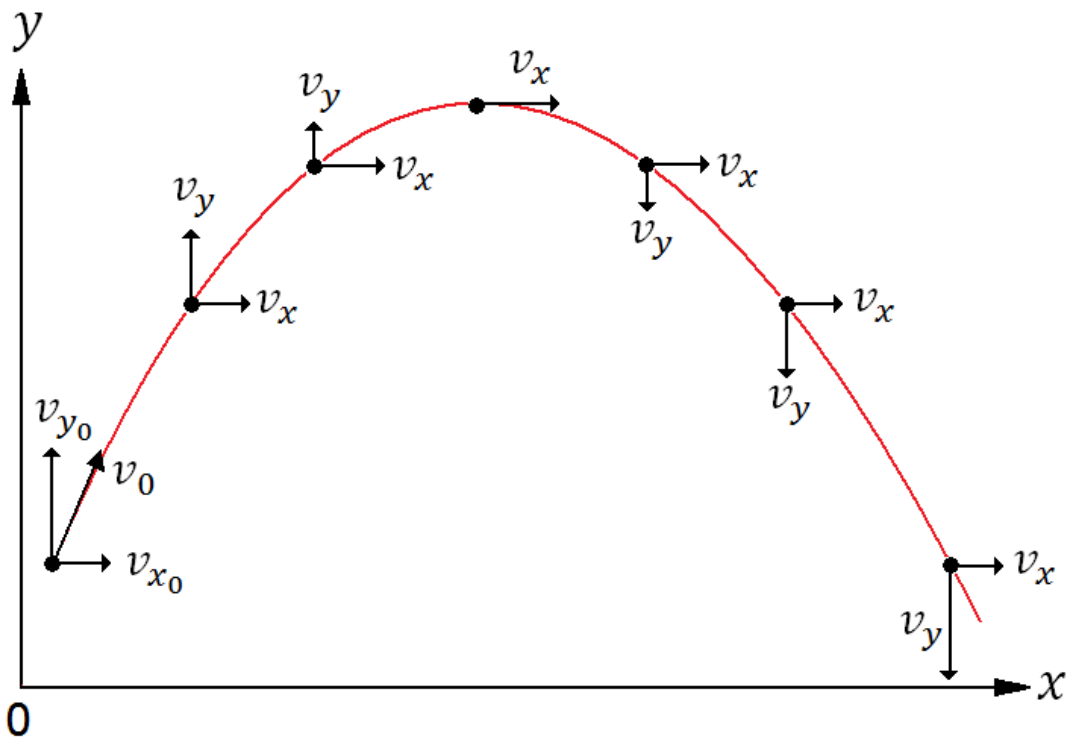
x

Horizontal and Vertical Velocity



A body is launched with a speed of $18.0\,\mathrm{m\,s^{-1}}$ at the following angles:

a 30° to the horizontal

b 0° to the horizontal

c 90° to the horizontal.

Find the x- and y-components of the initial velocity in each case.

Motion Diagram

Vertical and Horizontal Displacement

An object is launched horizontally from a height of 20 m above the ground with speed $15\,\mathrm{m\,s^{-1}}$. Determine:

a the time at which it will hit the ground

b the horizontal distance travelled

c the speed with which it hits the ground.

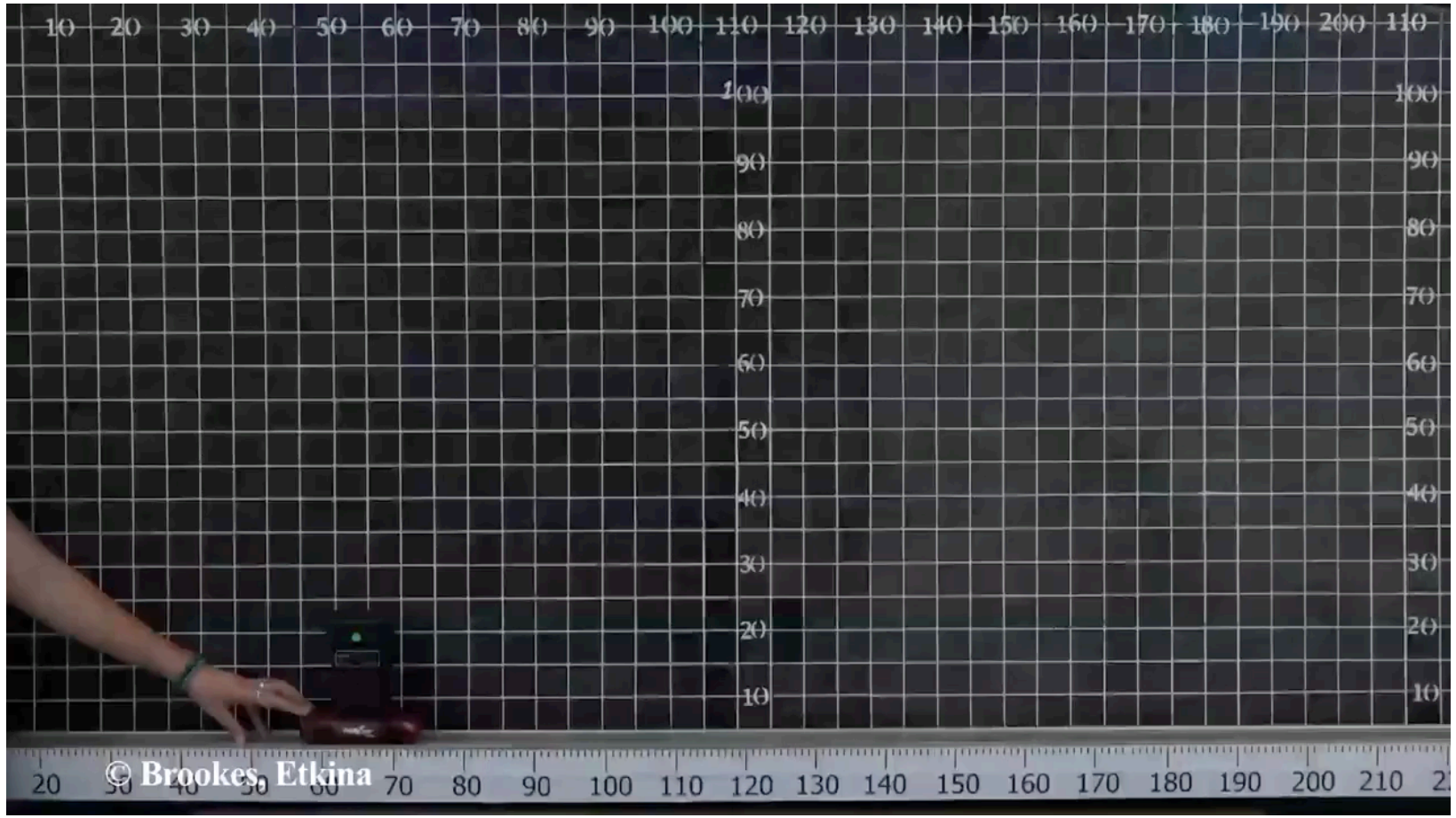
(Take $g = 10\,\mathrm{m\,s^{-2}}$.)

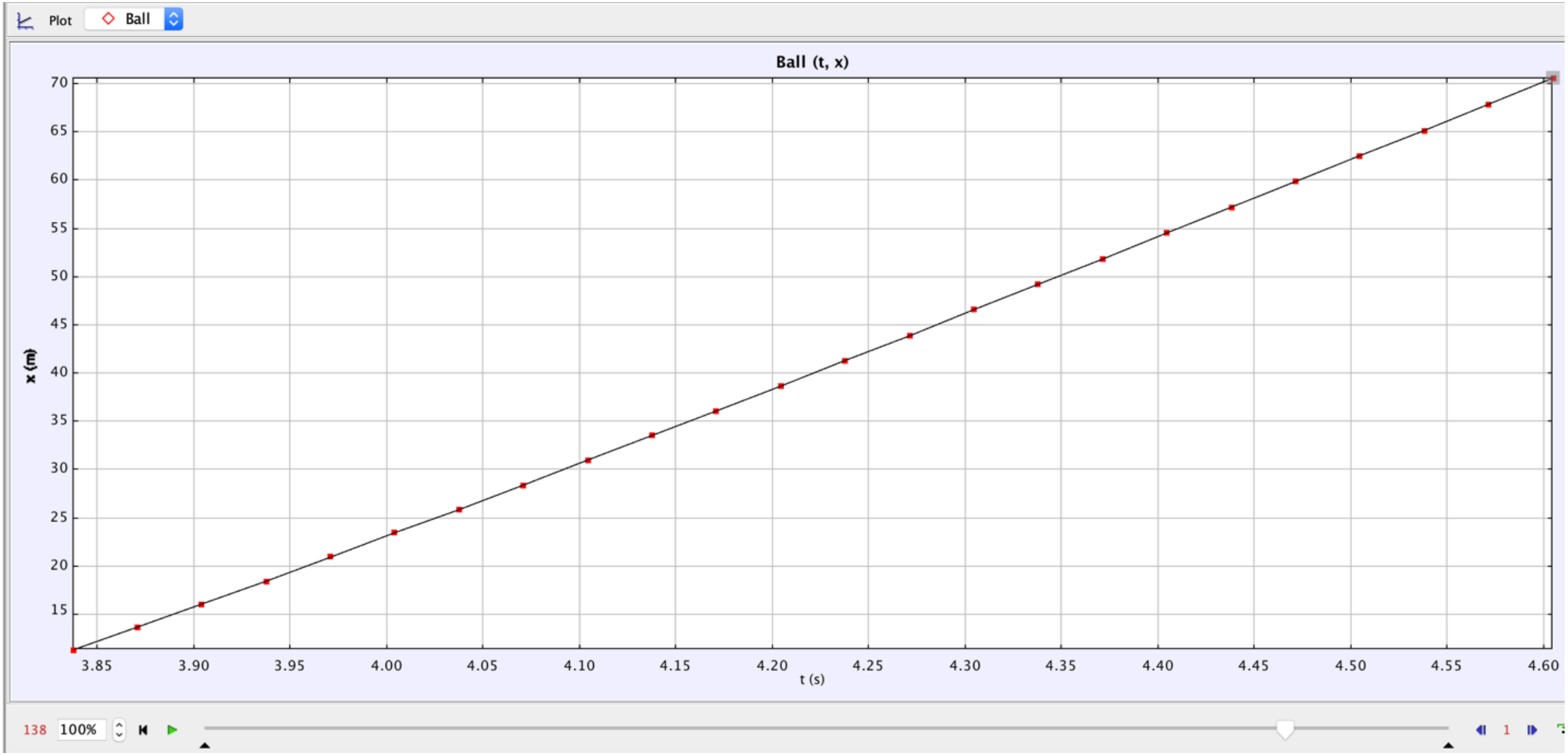
More Formulas, Maximum Height, etc

A projectile is launched at $32.0°$ to the horizontal with initial speed $25.0\,\mathrm{m\,s^{-1}}$. Determine the maximum height reached. (Take $g = 9.81\,\mathrm{m\,s^{-2}}$.)

Jason Kendall throws a baseball with a horizontal component of velocity of 25 m/s. It takes 3.00s to come back to its original height. Calculate its horizontal range, its initial vertical component of velocity and its initial angle of projection.

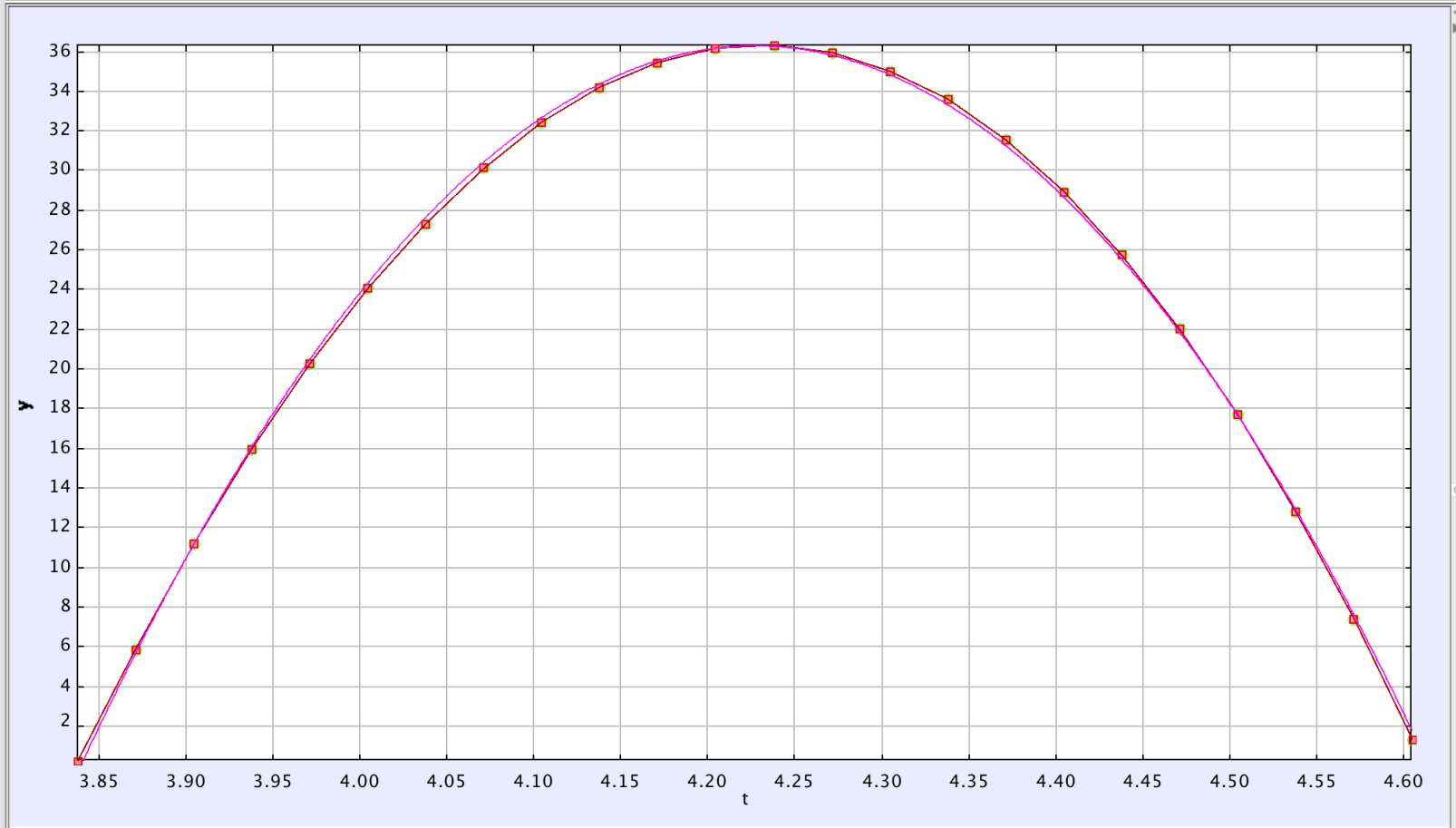
Trajectoty of Projectile Motion




Plot
Ball
Ball (t, x)
x (m)
70
65
60
55
50
45
40
35
30
25
20
15
3.85
3.90
3.95
4.00
4.05
4.10
4.15
4.20
4.25
4.30
4.35
4.40
4.45
4.50
4.55
4.60
t (s)
138
100%
1

Ball | Shotting_Ball

Measure | Analyze | Data Builder... | Refresh | Help



Fit Name: Parabola | Fit Builder

Fit Equation: y = A*t^2 + B*t + C

Autofit | rms dev: 2.454E-1

Parameter	Value
A	-2.416E2
B	2.042E3
C	-4.280E3

markers		☑	☐	☐	☐
lines		☑	☐	☐	☐
style					
axis	horiz	vert	vert	vert	vert
row	t	y	vy	vx	x
0	3.837	0.271			3.327
1	3.871	5.902	163.6	29.55	4.300
2	3.904	11.19	150.7	29.56	5.299
3	3.937	15.96	136.0	30.58	6.272
4	3.971	20.26	121.6	30.81	7.340
5	4.004	24.08	106.0	29.72	8.328
6	4.037	27.34	90.96	31.30	9.323
7	4.071	30.15	76.95	32.46	10.42
8	4.104	32.47	61.26	32.25	11.49
9	4.137	34.24	45.06	31.75	12.57
10	4.171	35.48	29.56	31.53	13.61
11	4.204	36.21	13.32	31.71	14.67
12	4.238	36.37	-3.202	32.16	15.72
13	4.271	36.00	-19.94	33.27	16.82
14	4.304	35.04	-35.25	33.92	17.94
15	4.338	33.64	-52.33	33.32	19.08
16	4.371	31.54	-70.32	32.96	20.17
17	4.404	28.95	-86.73	33.21	21.28
18	4.438	25.76	-103.8	33.10	22.38
19	4.471	22.02	-120.4	33.34	23.49
20	4.505	17.72	-138.1	32.69	24.61
21	4.538	12.81	-154.4	33.18	25.67
22	4.571	7.417	-171.8	33.83	26.82
23	4.605	1.347			27.93

Questions To Think About

- Why is the trajectory of vertical component vs time is a parablic function?

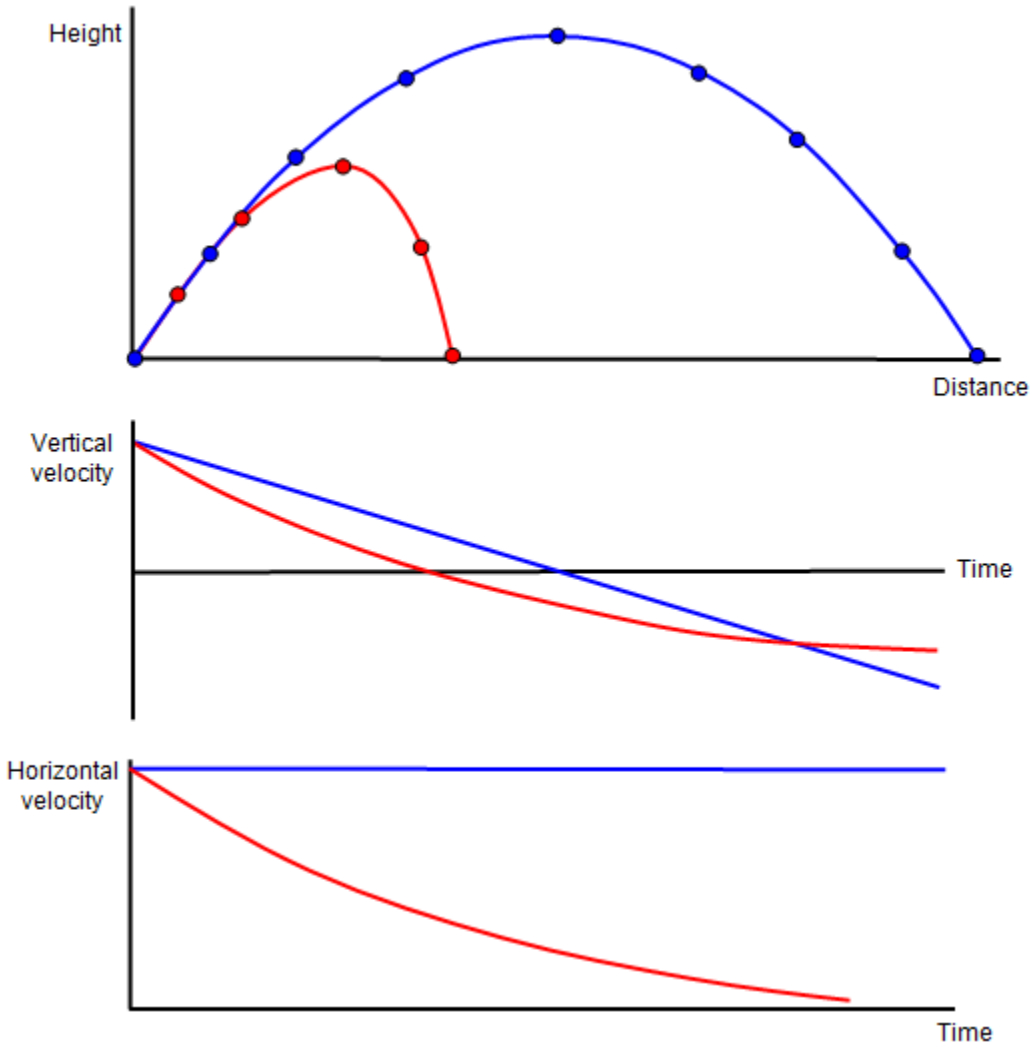
- Why is vertical velocity vs time a linear function?

Hint: Kinematics Equations

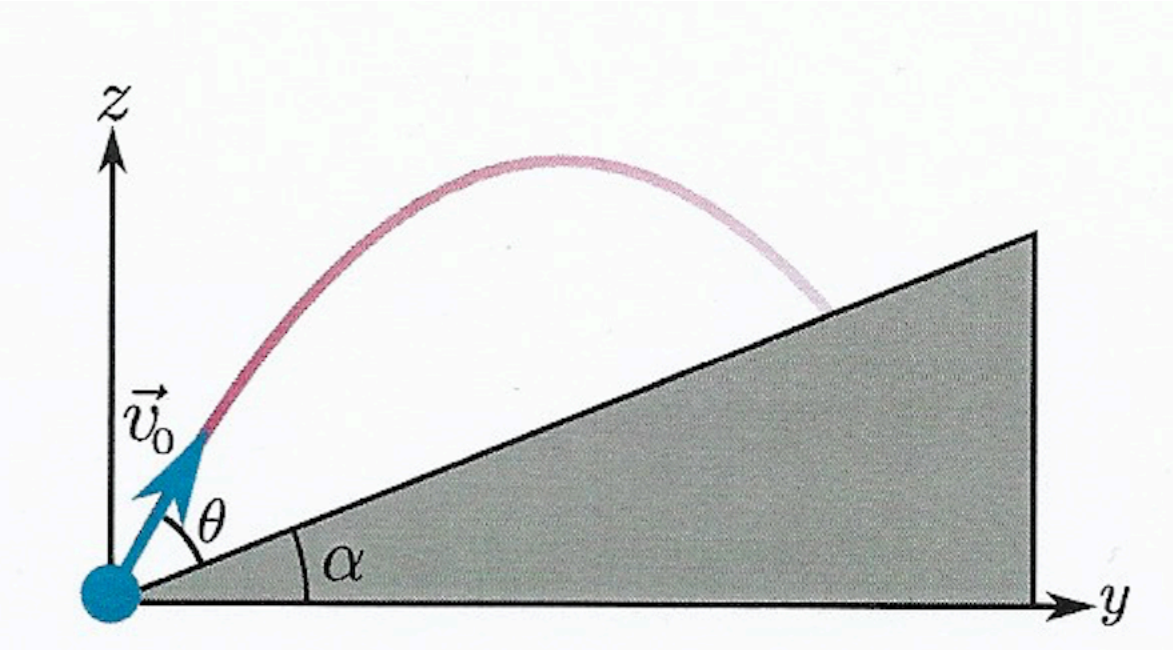
Projectile Without Fluid Resistance

Drag Force

Projectile with Fluid Resistance



Terminal Velocity

Motion on An Inclined Plane

Projectile Motion on An Inclined Plane