It's Ain't Over Till It's Over! 1

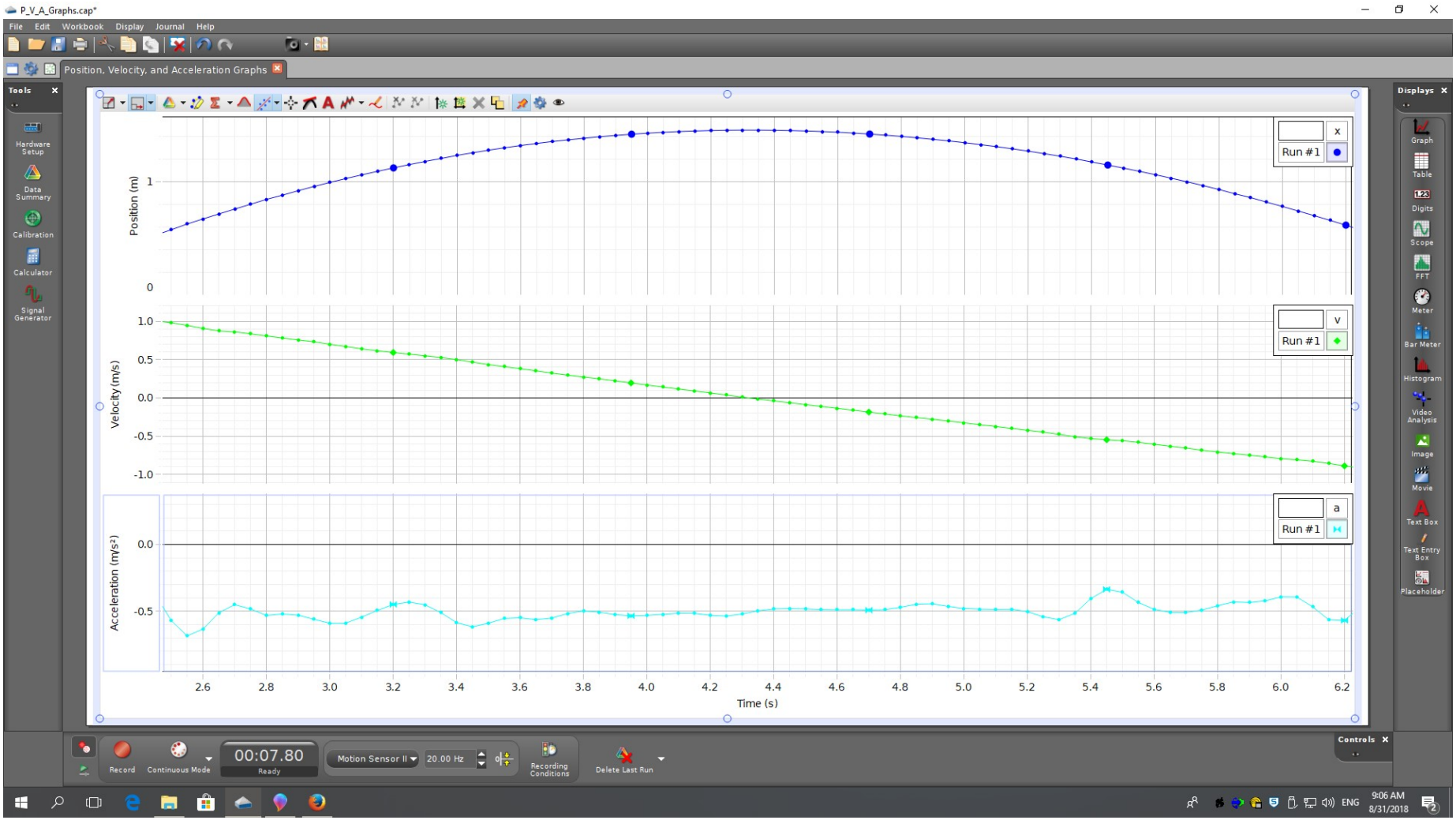
On January 31, 2005 Randolph-Macon College (RMC) was playing Guilford College in basketball at Randolph-Macon in Ashland, Virginia. The teams are tied 88-88 with just a fraction of a second in overtime. RMC in yellow sinks a free throw to win the game (at least they thought they won). The second free throw is missed. Jordan Snipes from Guilford (in purple) rebounds the ball and gets a shot off just milliseconds before the buzzer. The rest is history.

How hard is this? 2

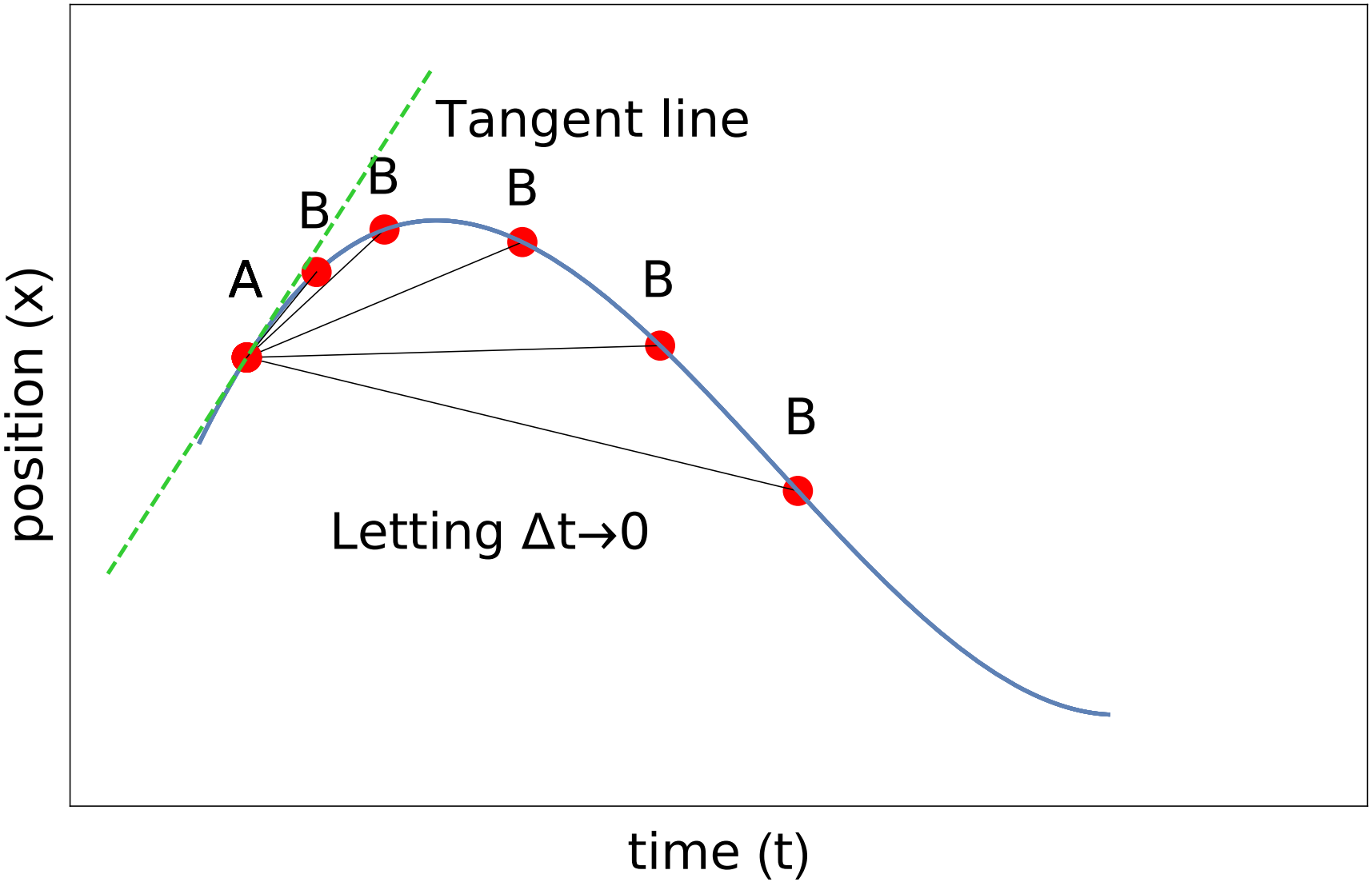
Consider the accuracy of the shot by Snipes. If he released the ball at an angle $\theta = 35^\circ$ to the horizontal and from an initial height above the floor $y_0 = 2.4\ m$, then how accurately must he judge the speed of the ball at launch? Some useful parameters are below.

Horizontal distance to center of basket:	22 m
Basket height:	3.10 m
Basket diameter:	0.46 m
Ball diameter:	0.239 m

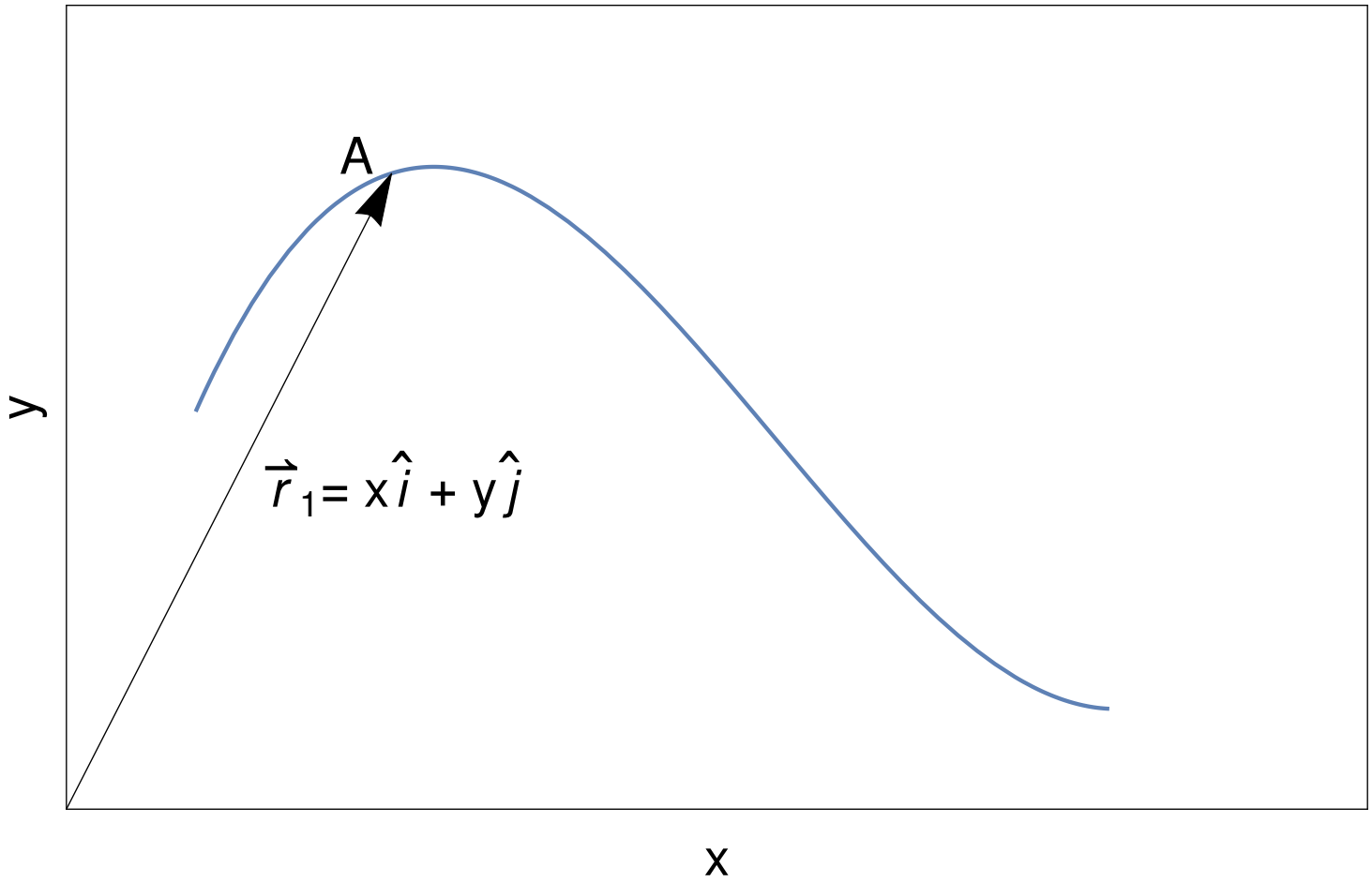
Turning Around 1 3



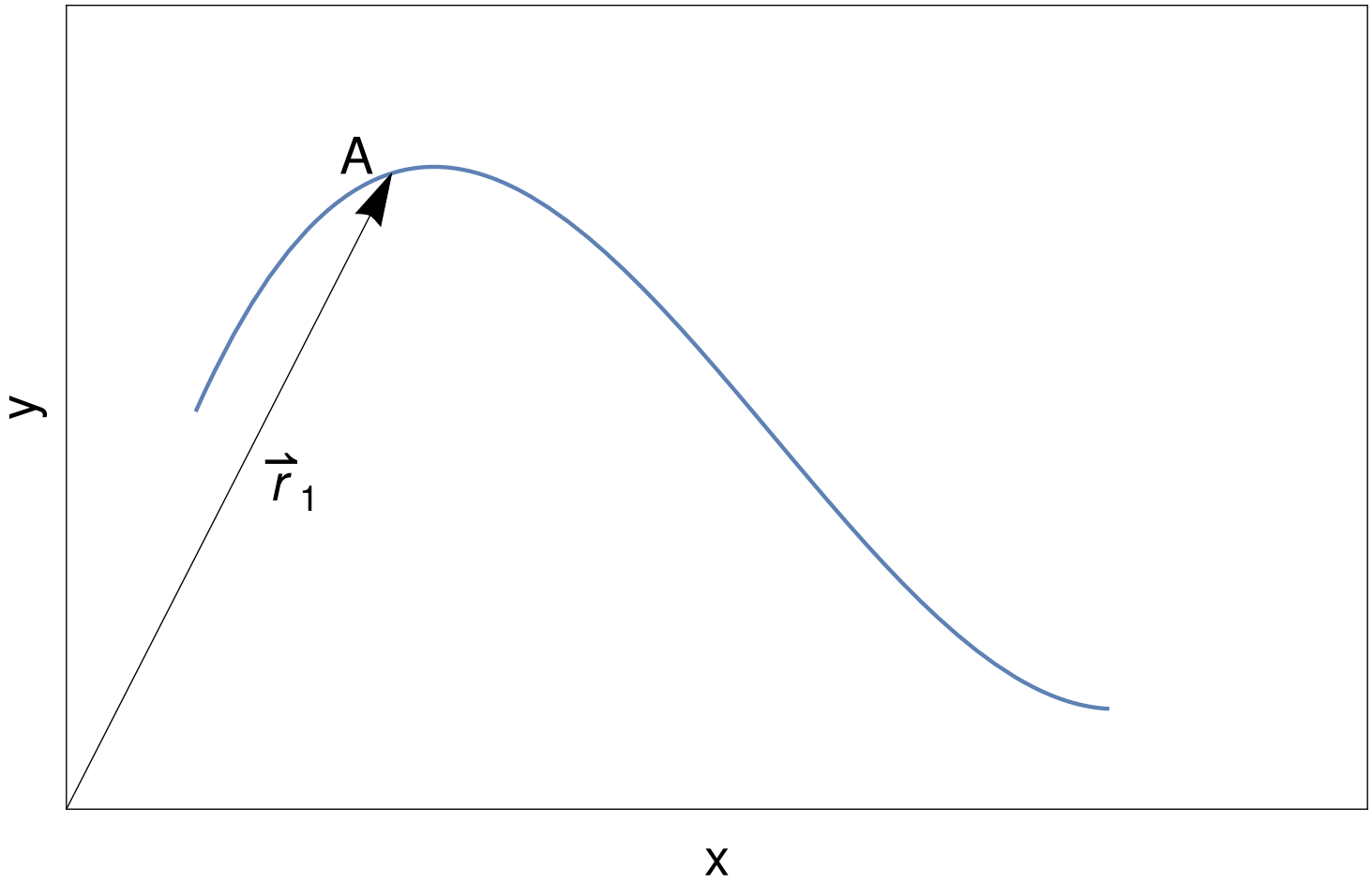
Recall Instantaneous Velocity 4



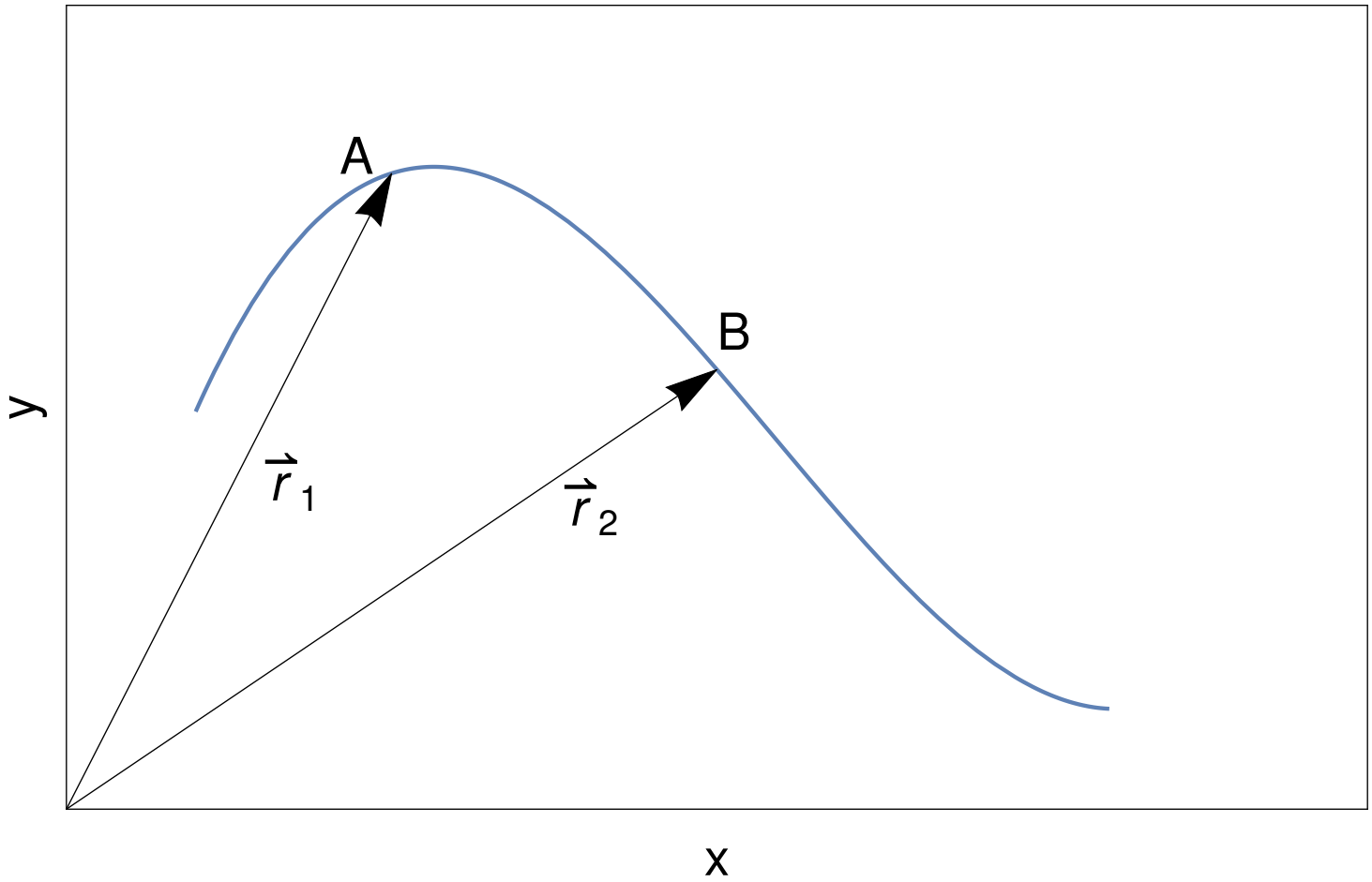
Visualizing Projectile Motion 5



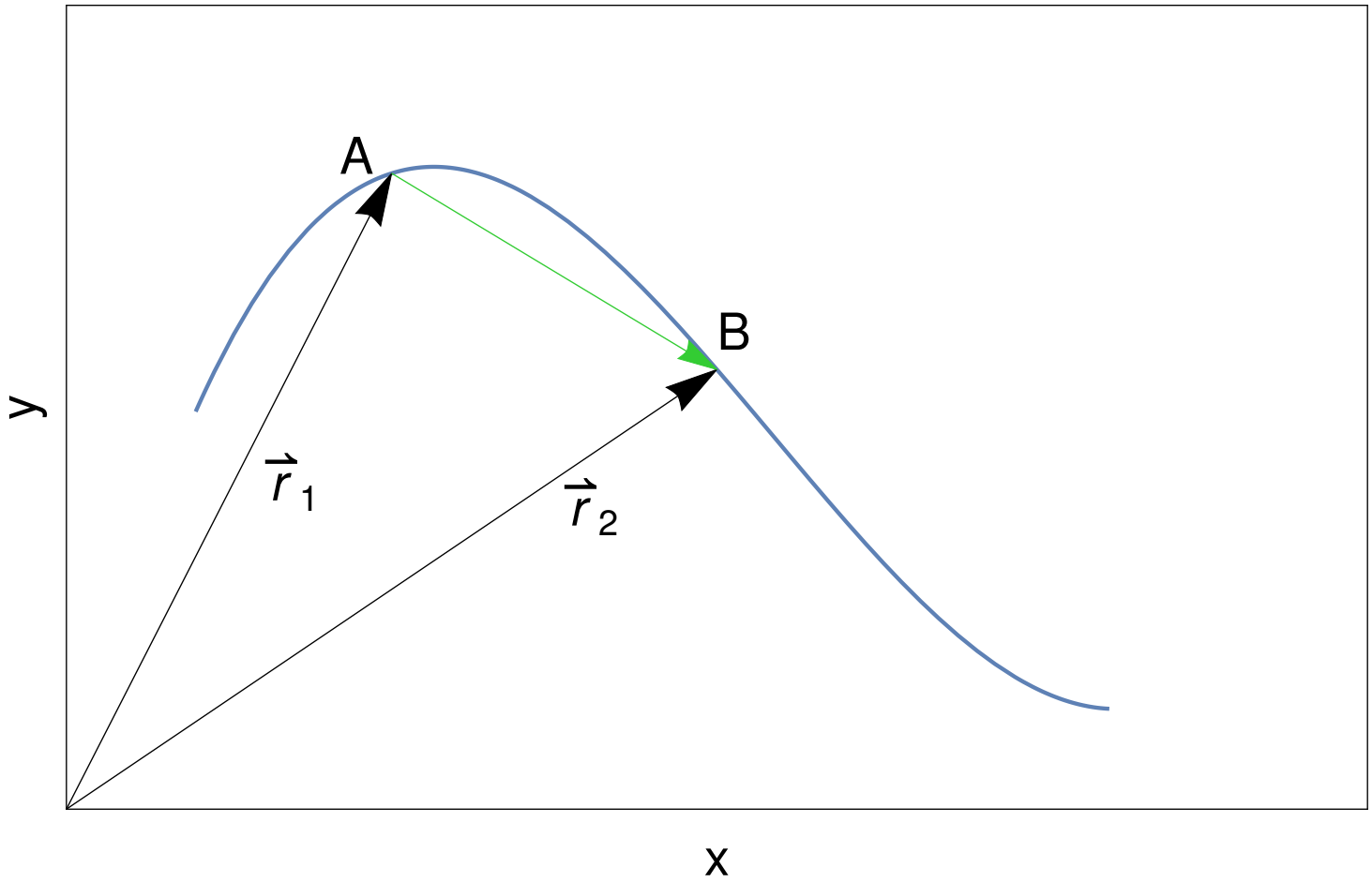
Visualizing Projectile Motion 6



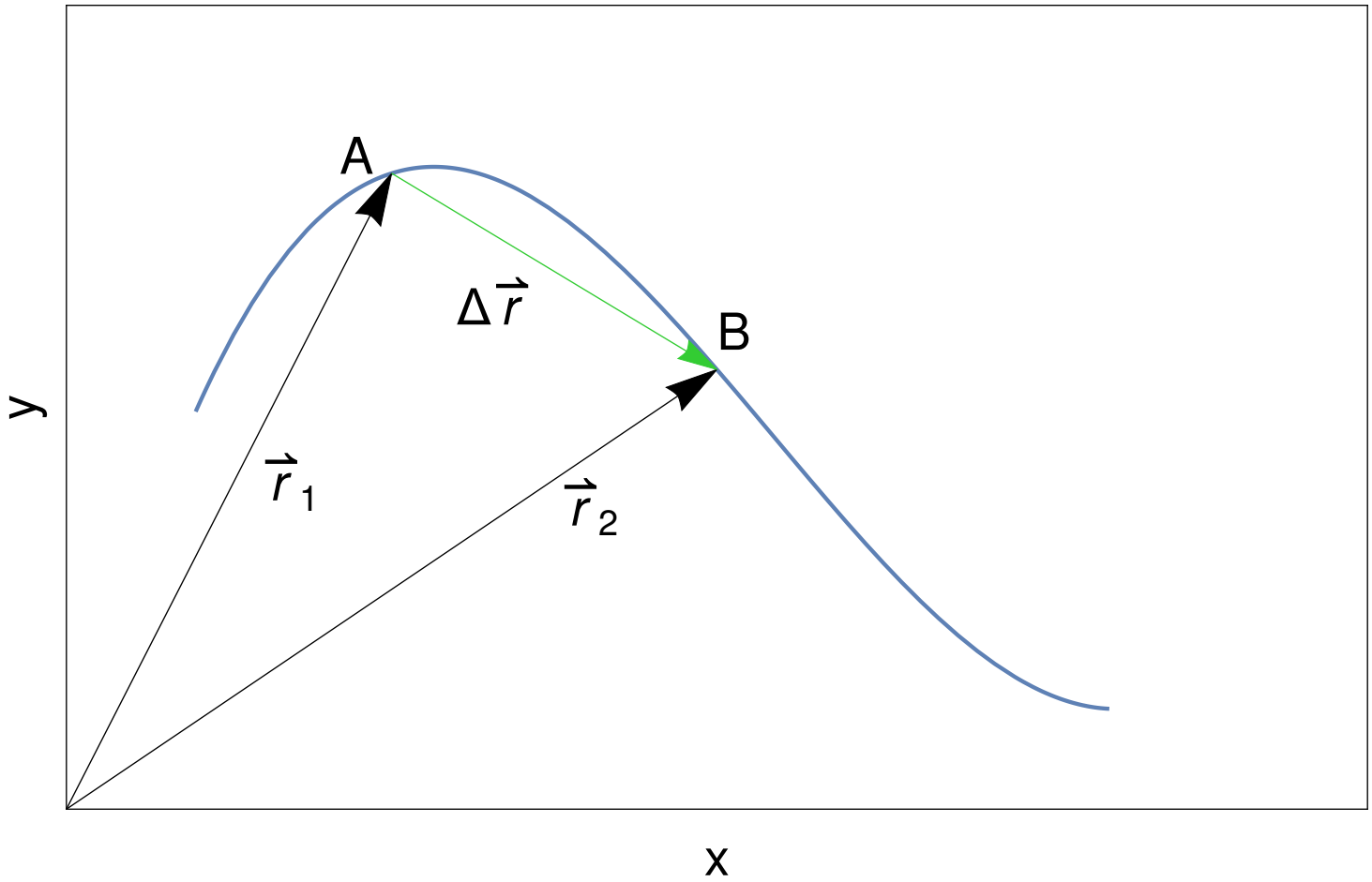
Visualizing Projectile Motion 7



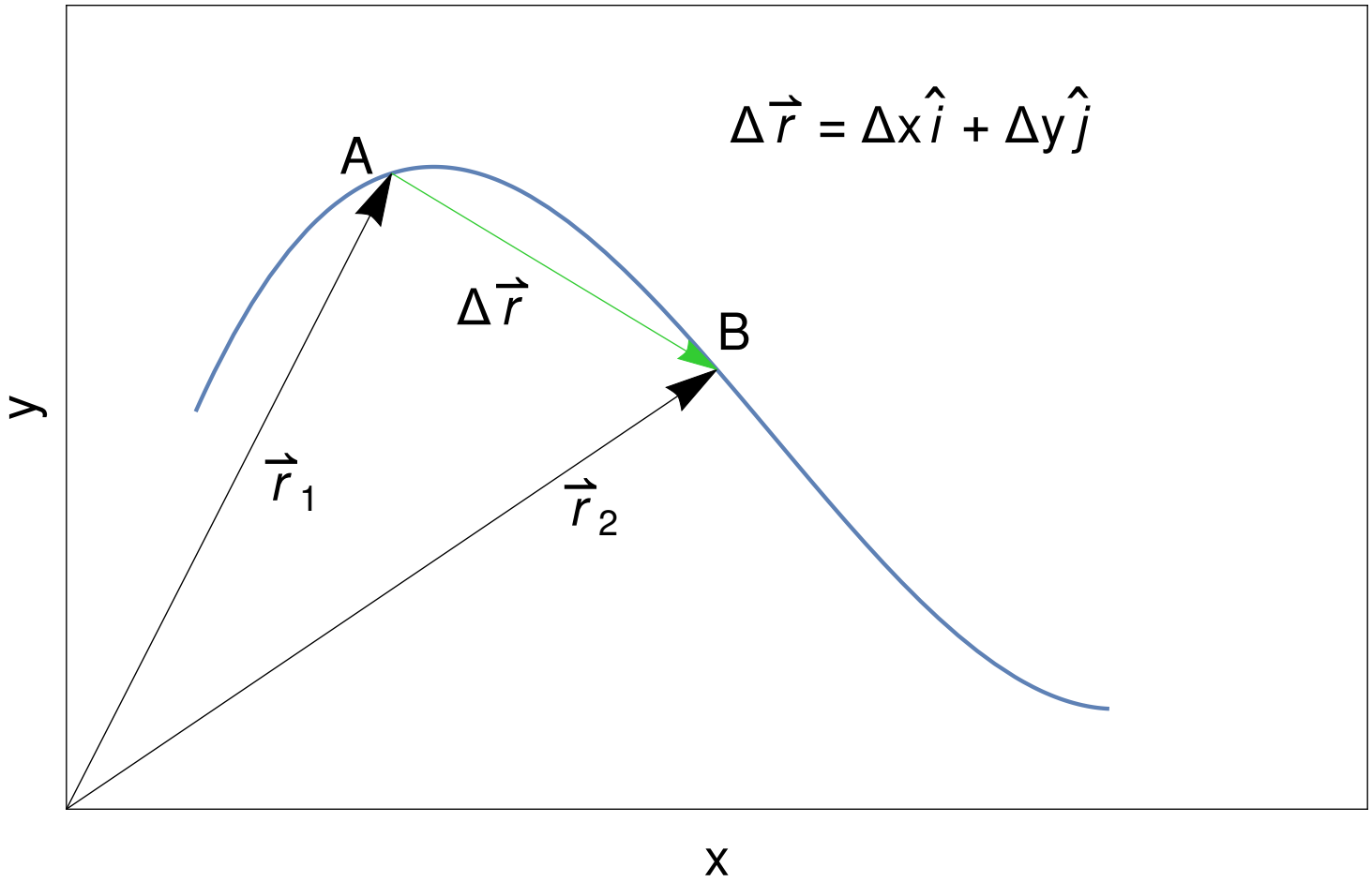
Visualizing Projectile Motion 8

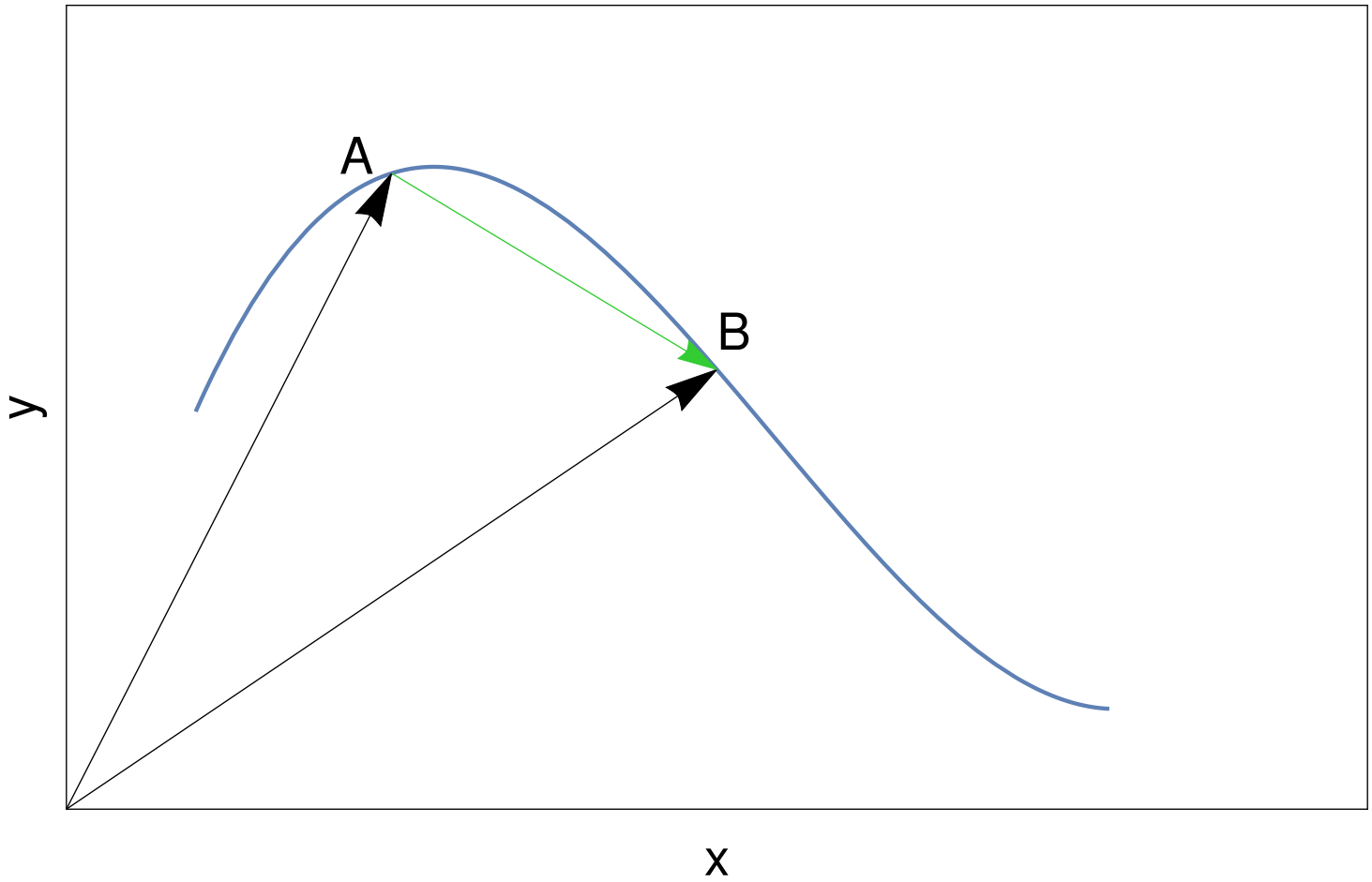


Visualizing Projectile Motion 9

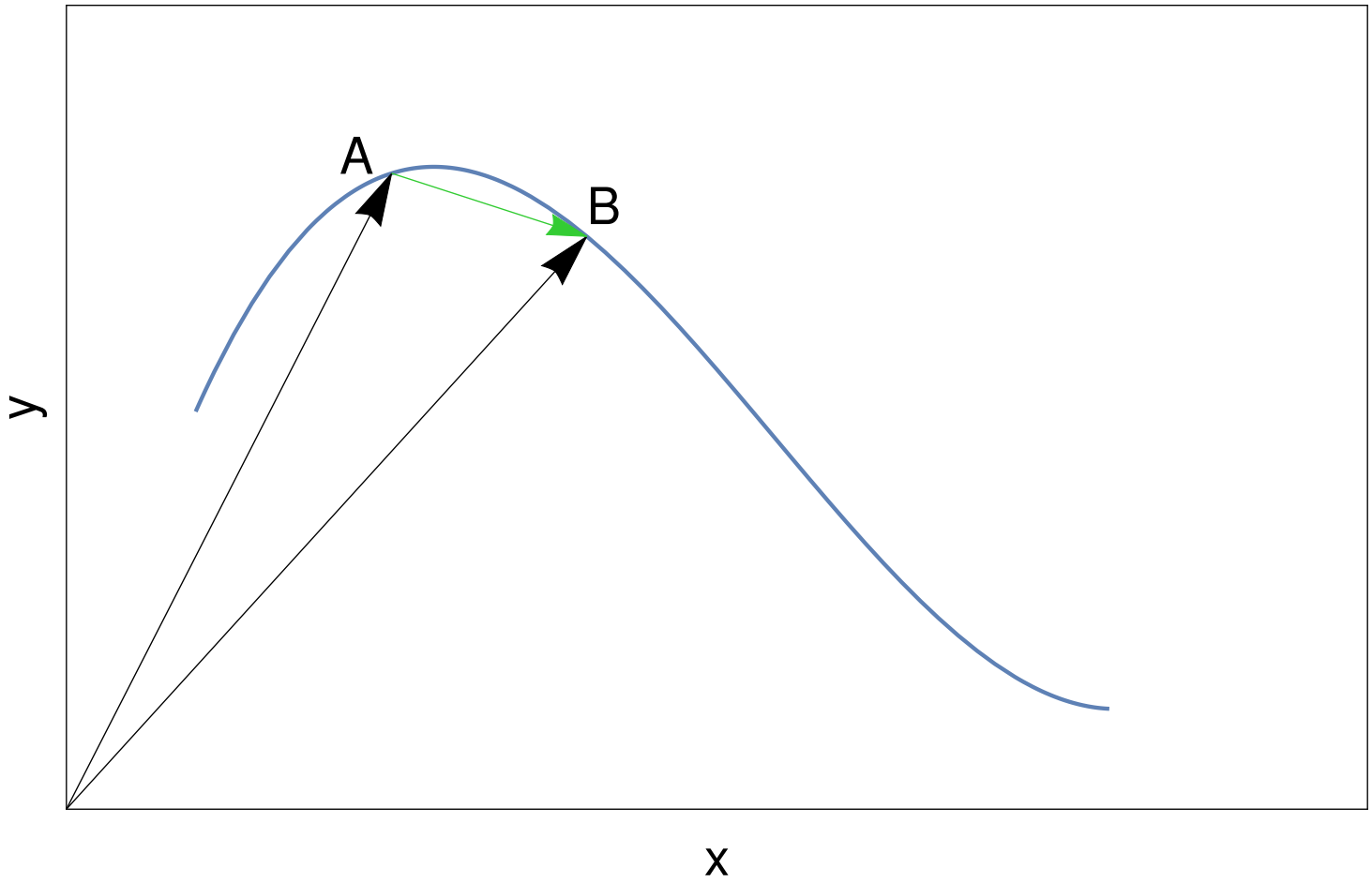


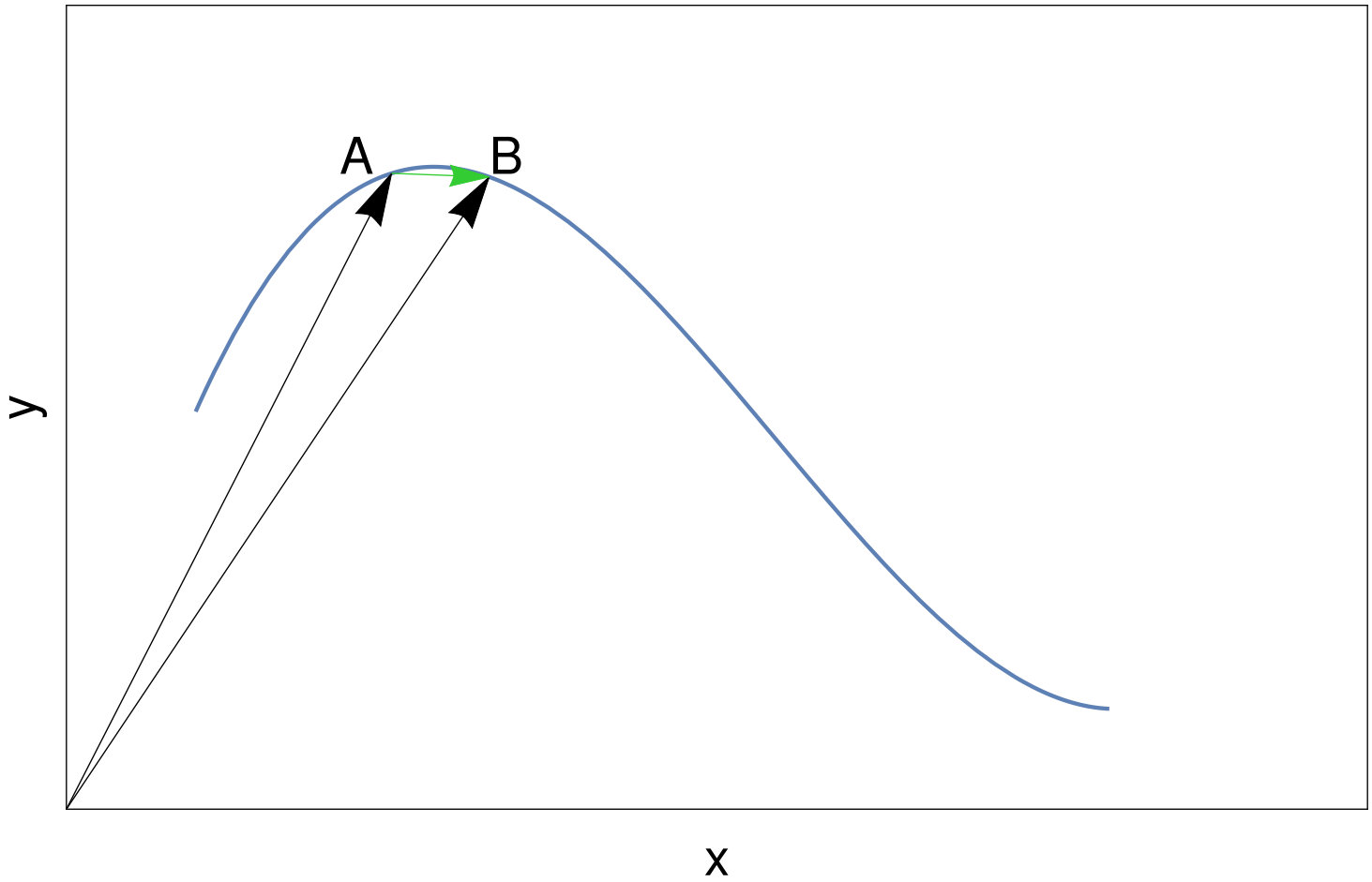
Visualizing Projectile Motion 10

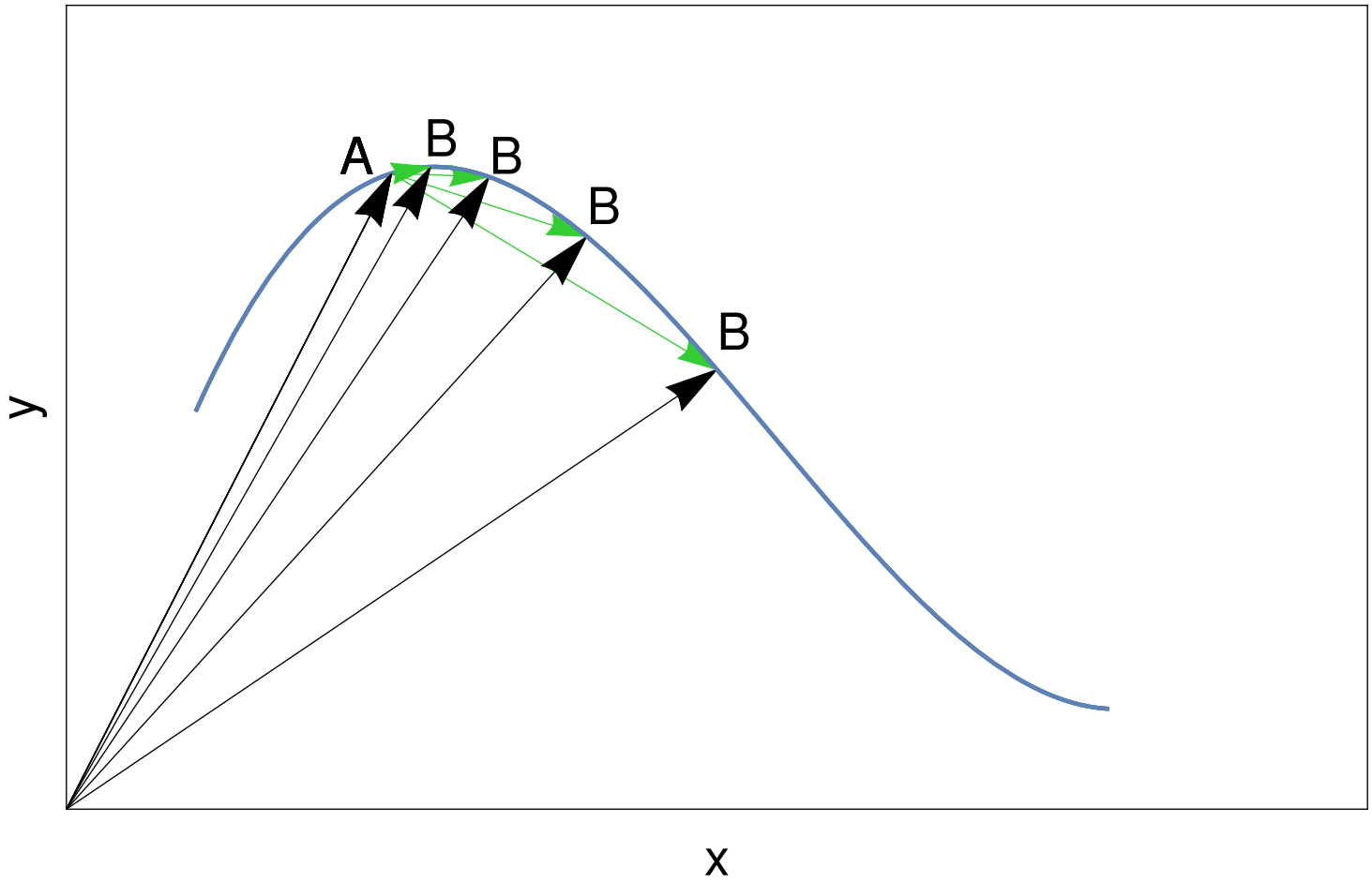



A
B
y
x

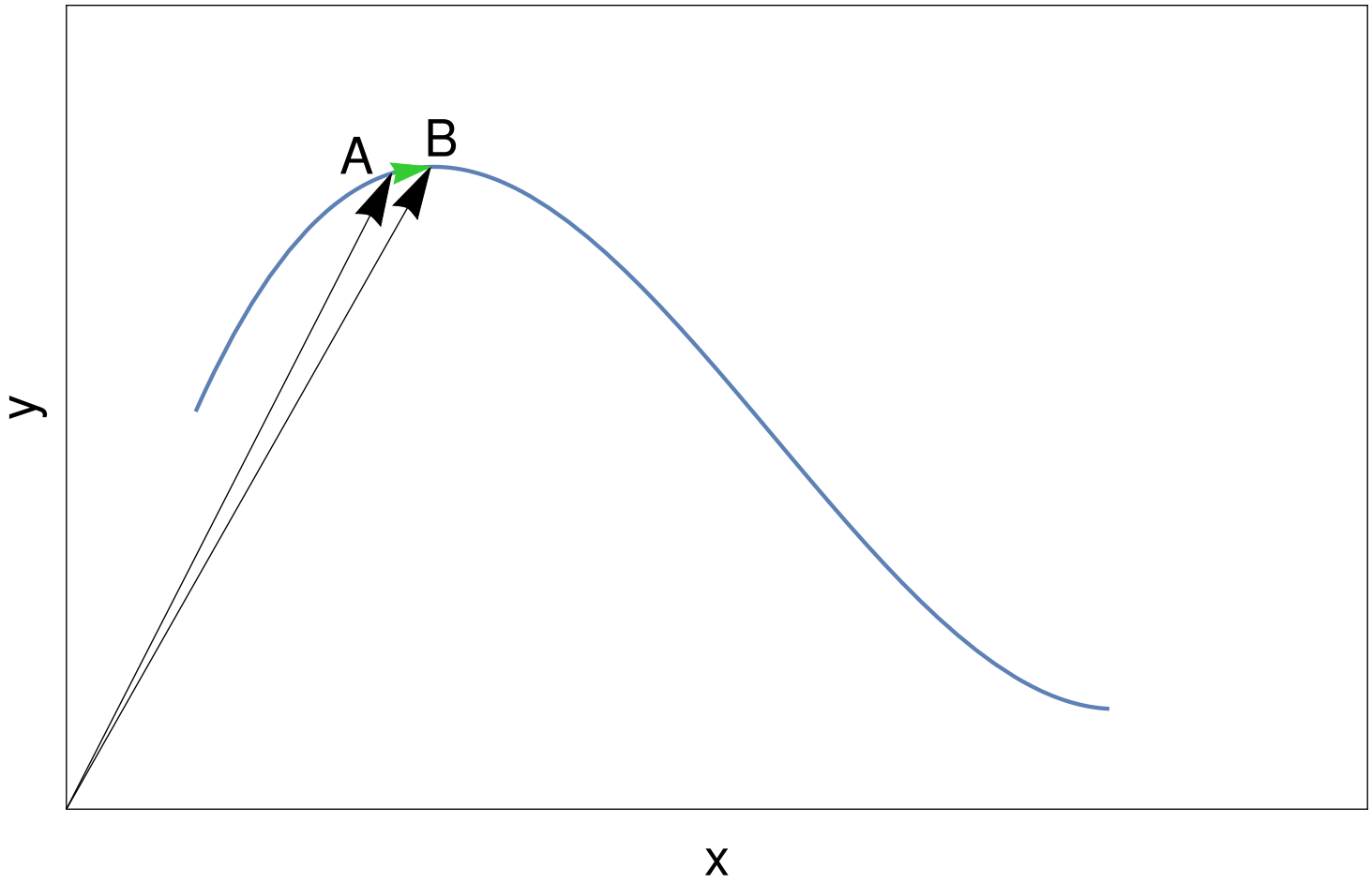
Visualizing Projectile Motion 12



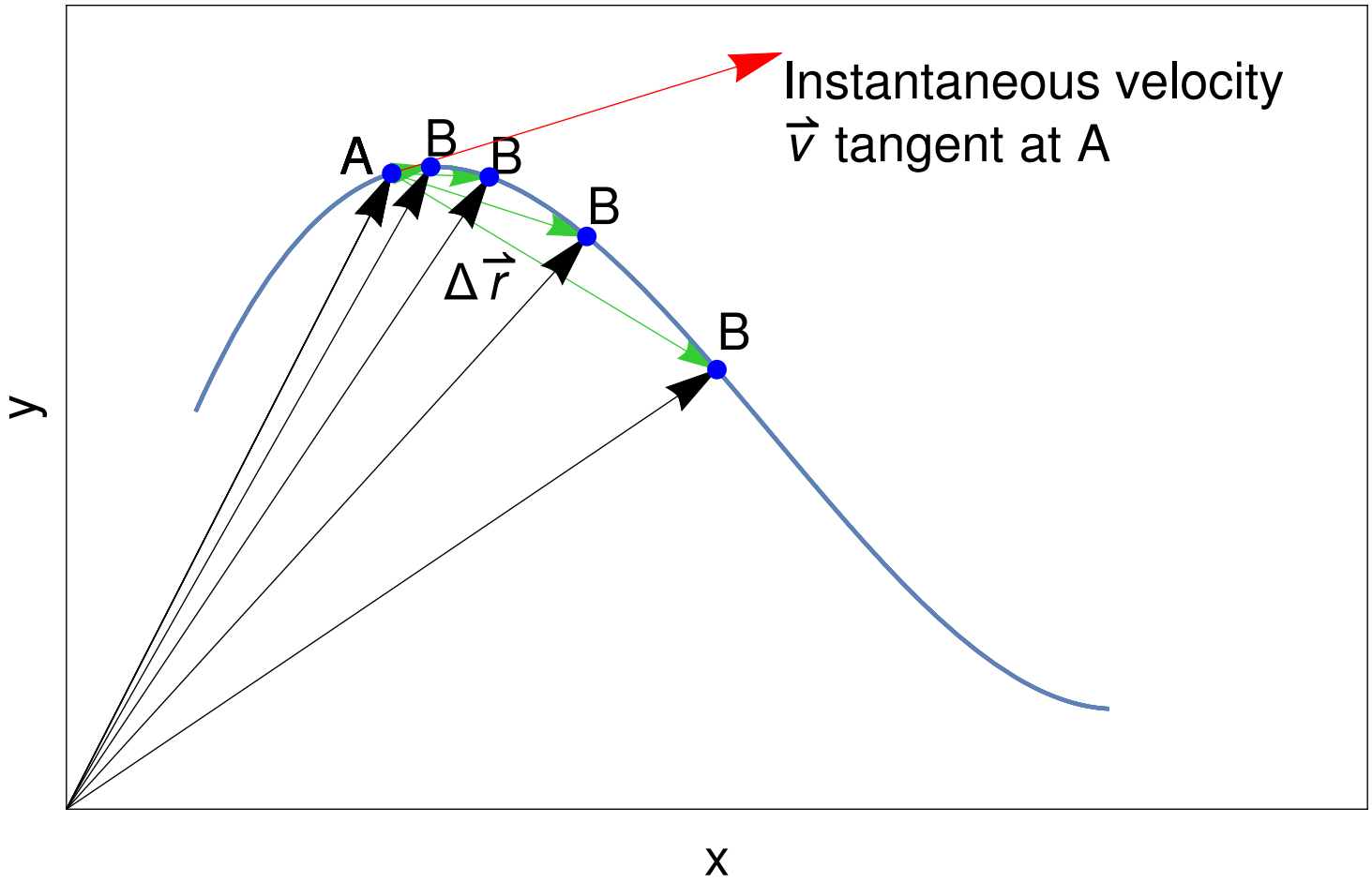

A
B
y
x

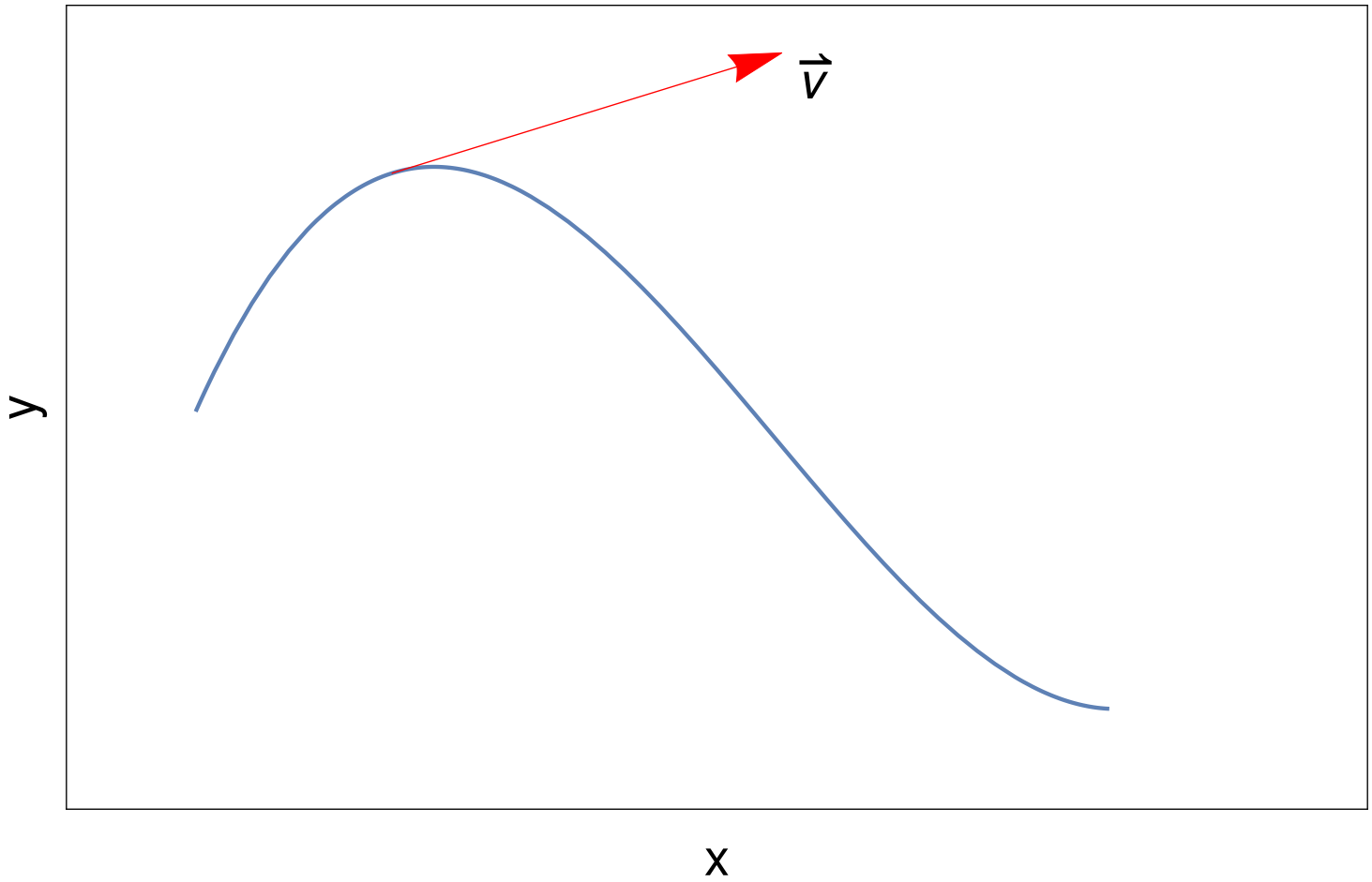

A
B
B
B
B
y
x

Visualizing Projectile Motion 15

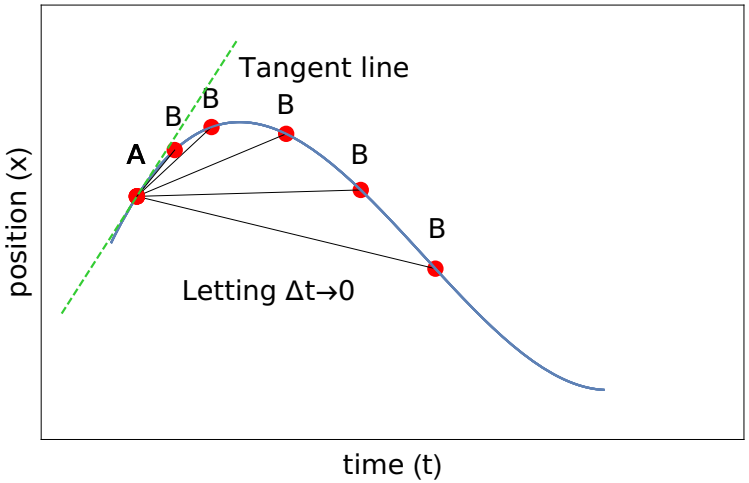


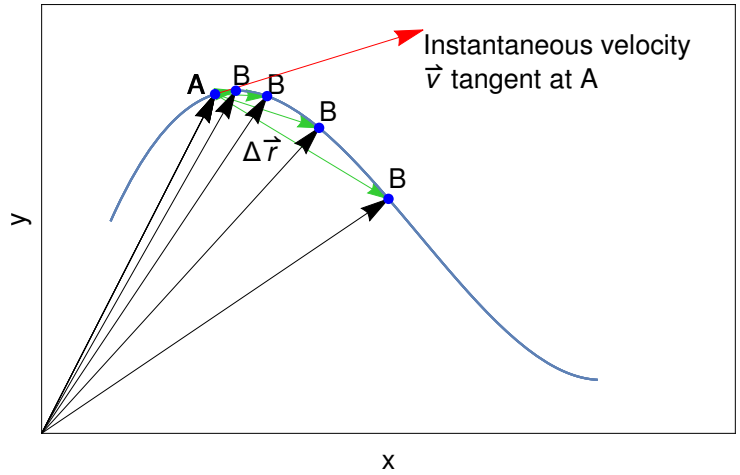
Visualizing Projectile Motion 16



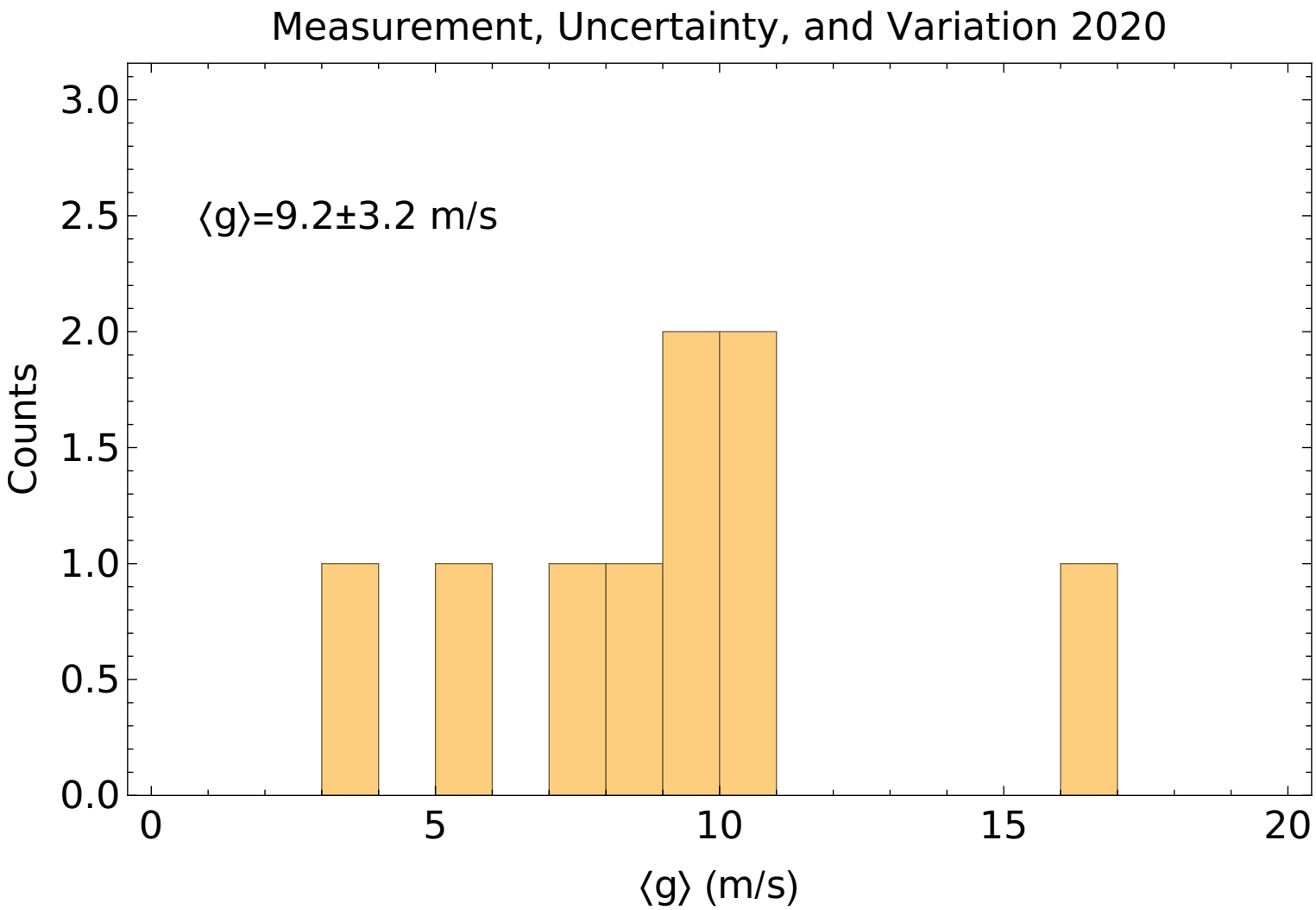

$\vec{v}$
y
x

We'll use these plots to visualize and analyze motion, but they represent different quantities.





Results from **Measurement, Uncertainty, and Variation** 19



The trebuchet at Warwick Castle in the UK is home to one of the world's largest working siege engines. It takes eight men half an hour to load and release. On 21 August 2006, the trebuchet launched a projectile weighing 13 kilograms (29 lb) at a record speed of 54 m/s (121 mph). If the height of the projectile at launch is $y_0 = 20\ m$ and the launch angle is $\theta = 30°$, then how far does it go before it lands? Assume there is no air friction and the ground is flat.

Consider the accuracy of the shot by Snipes. If he released the ball at an angle $\theta = 35^\circ$ to the horizontal and from an initial height above the floor $y_0 = 2.4\ m$, then how accurately must he judge the speed of the ball at launch? Some useful parameters are below.

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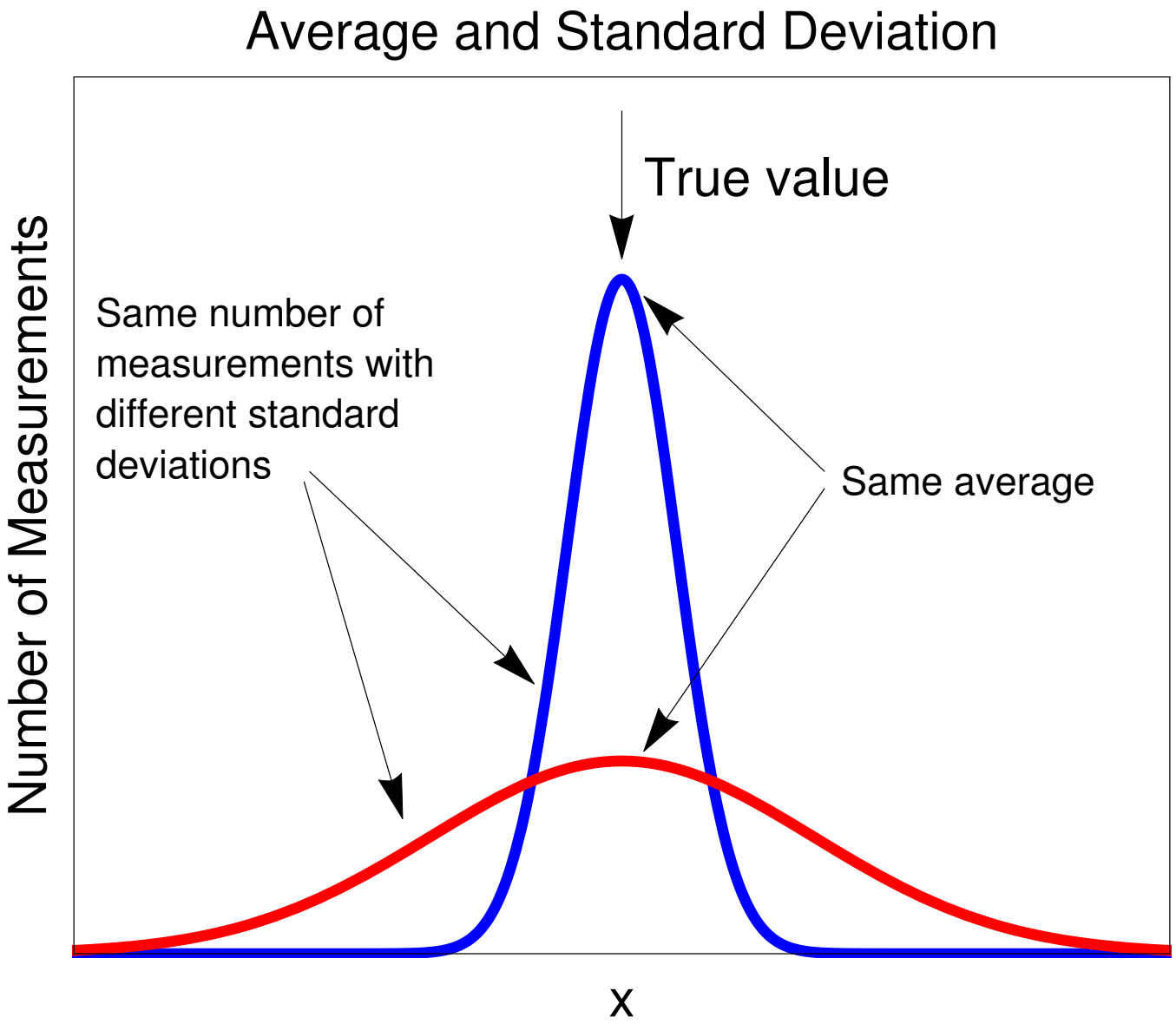
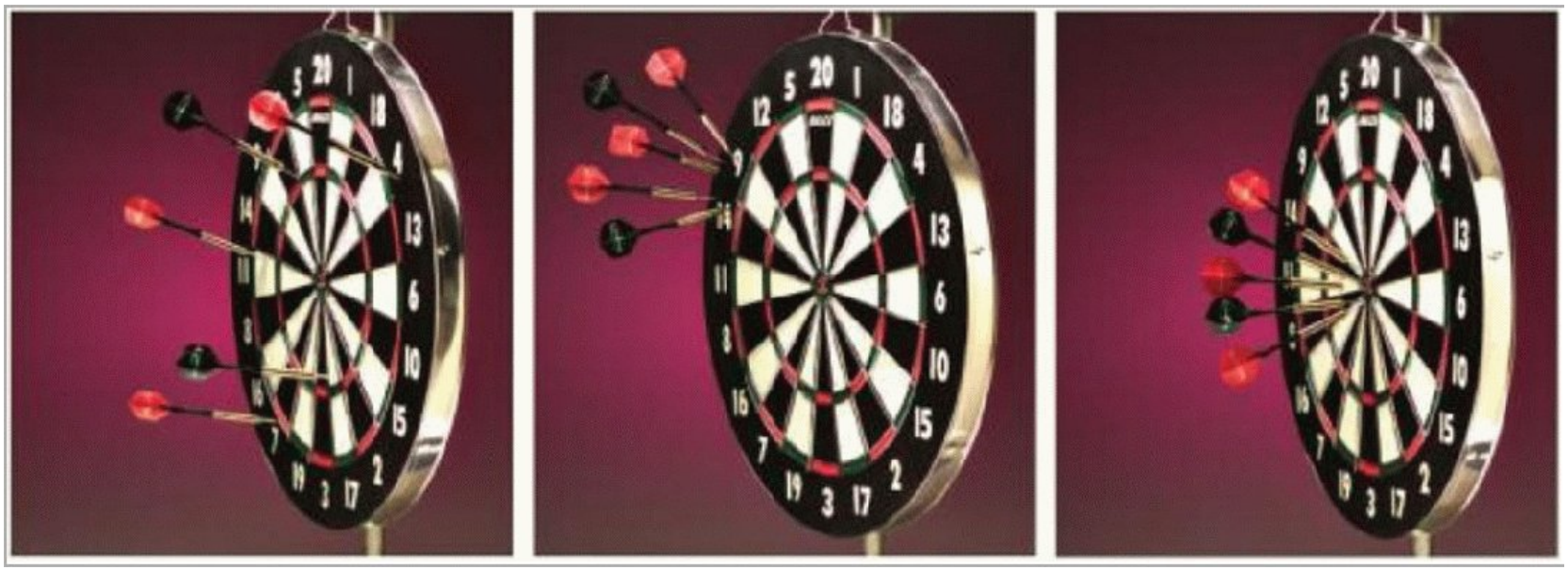
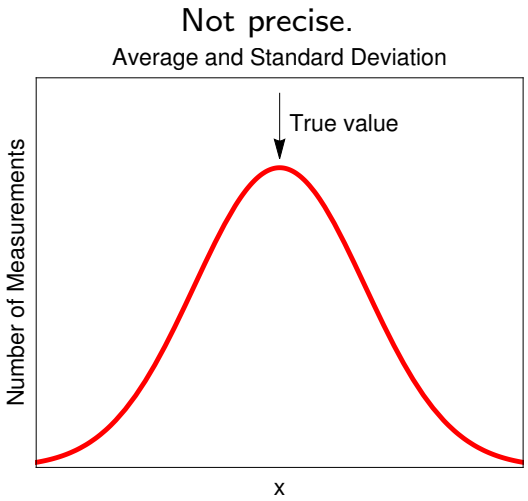
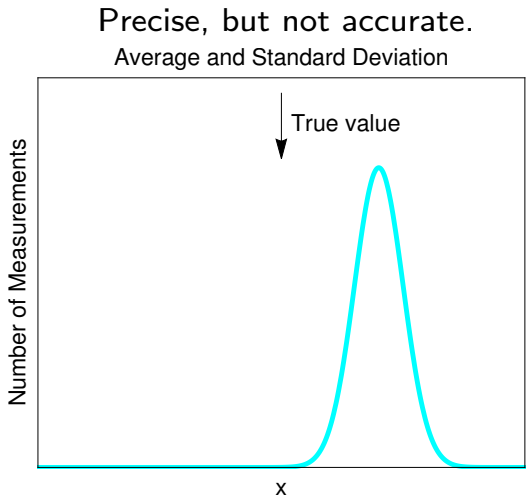
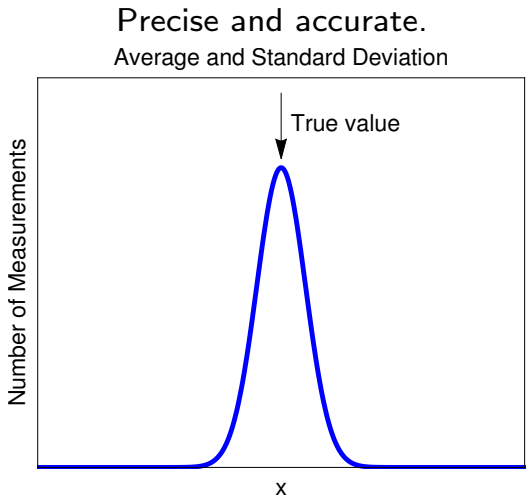
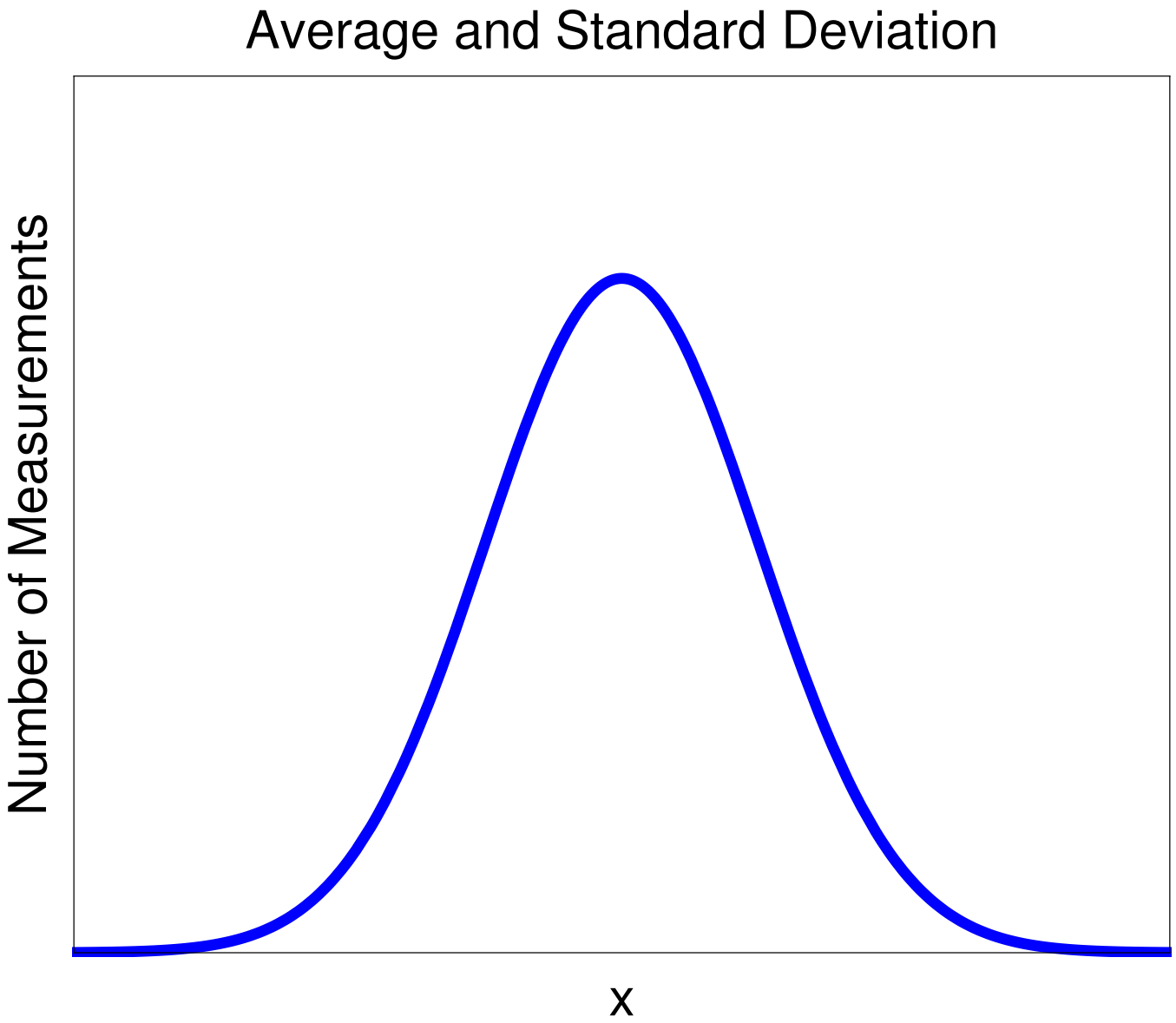

Average and Standard Deviation
True value
Same number of measurements with different standard deviations
Same average
Number of Measurements
x

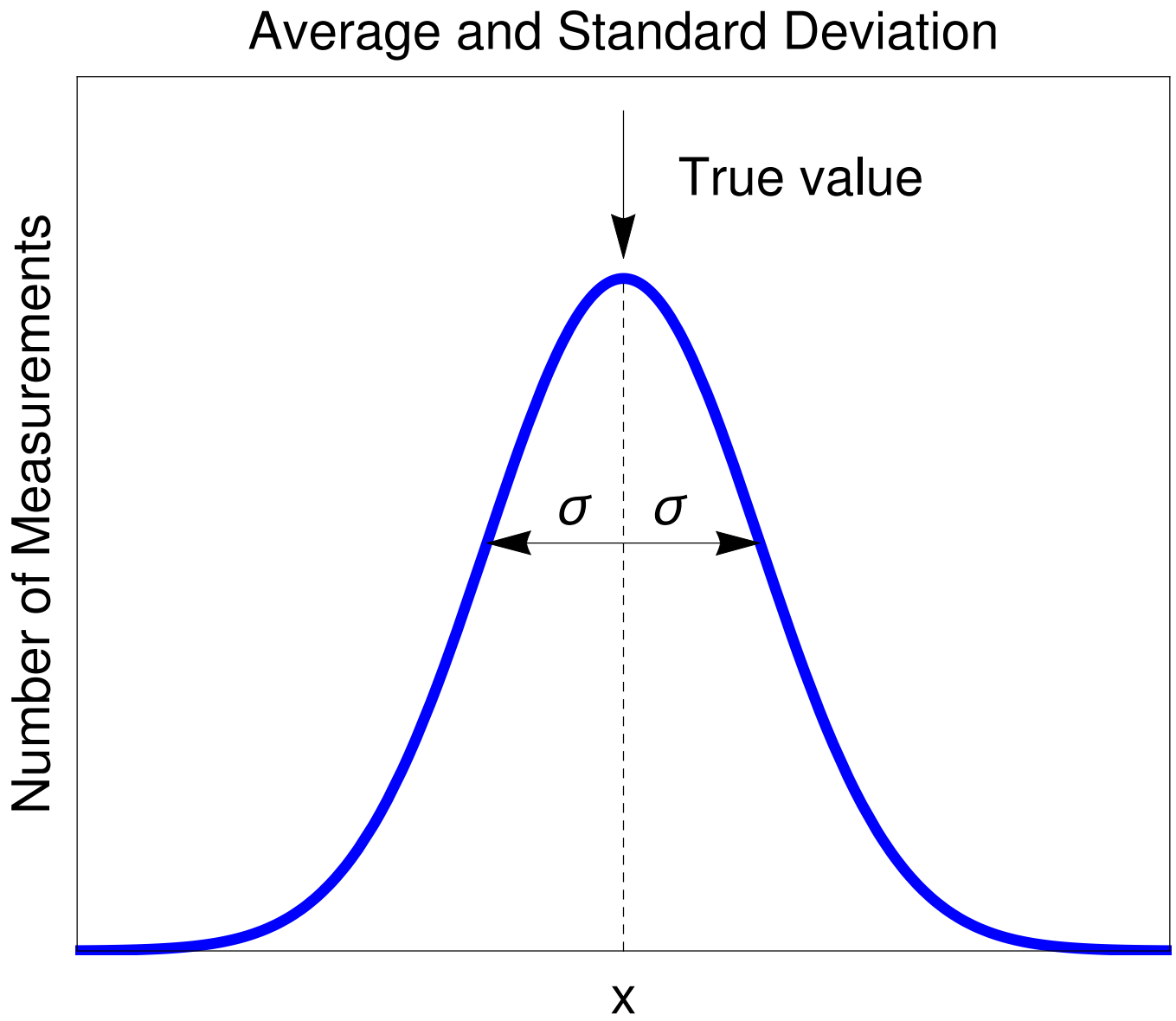


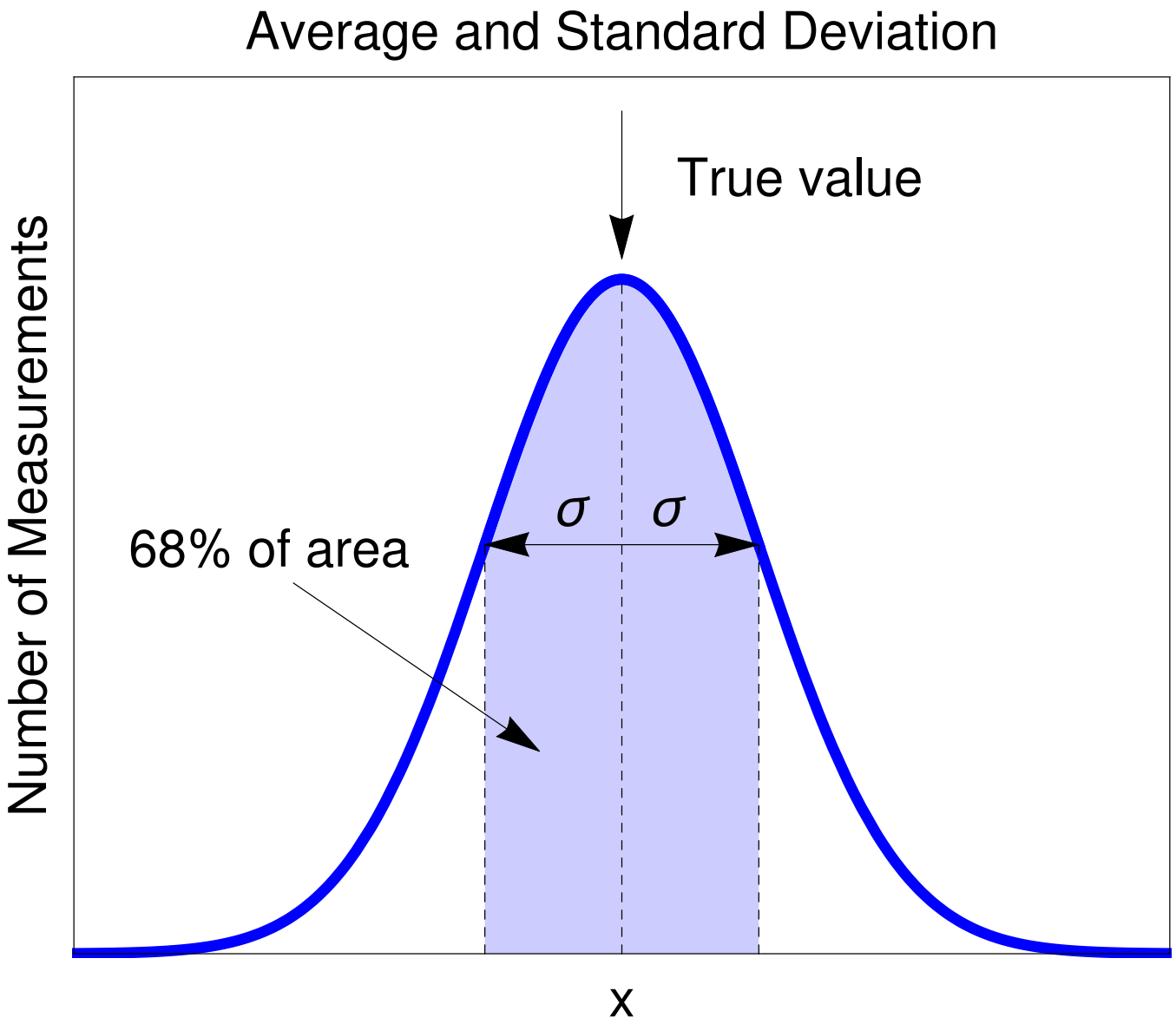

Not precise.
Average and Standard Deviation
True value
Number of Measurements
x


Precise, but not accurate.
Average and Standard Deviation
True value
Number of Measurements
x


Precise and accurate.
Average and Standard Deviation
True value
Number of Measurements
x


Average and Standard Deviation
Number of Measurements
x


Average and Standard Deviation
True value
σ
σ
Number of Measurements
x


Average and Standard Deviation
True value
Number of Measurements
68% of area
σ
σ
x

Projectile (2019, m/s^2)	Projectile (2018, m/s^2)
11.92	12.19
11.078	9.89
11.4	12.06
9.82	14.13
12.55	11.90
11.68	9.79
10.43	10.62
	13.29
11.2 ± 0.9	11.7 ± 1.5

Freefall (m/s^2)	Projectile (m/s^2)
10.34	12.19
11.04	9.89
13.11	12.06
11.90	14.13
11.6	11.90
9.84	9.79
9.94	10.62
13.72	13.29
11.4 ± 1.4	11.7 ± 1.5