

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](#).



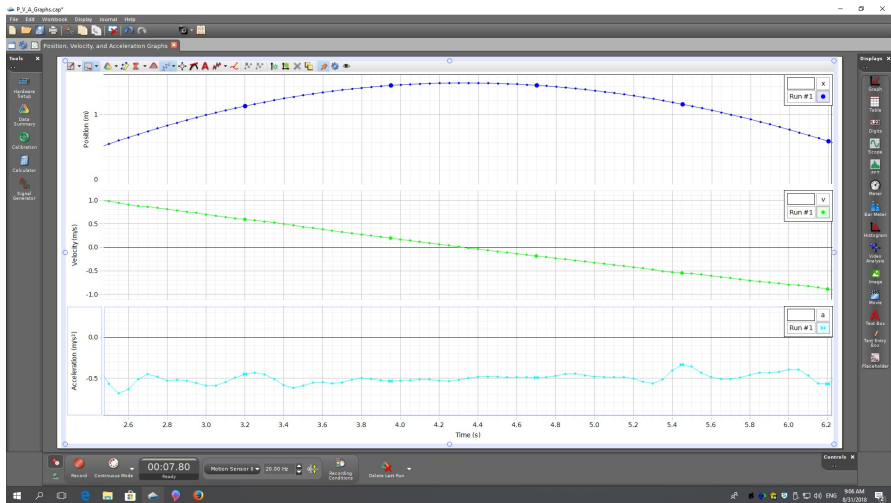
Consider the accuracy of the shot by Snipes. If he released the ball at an angle  $\theta = 35^\circ$  to the horizontal and from an initial height above the floor  $y_0 = 2.4 \text{ m}$ , then how accurately must he judge the speed of the ball at launch? Some useful parameters are below.

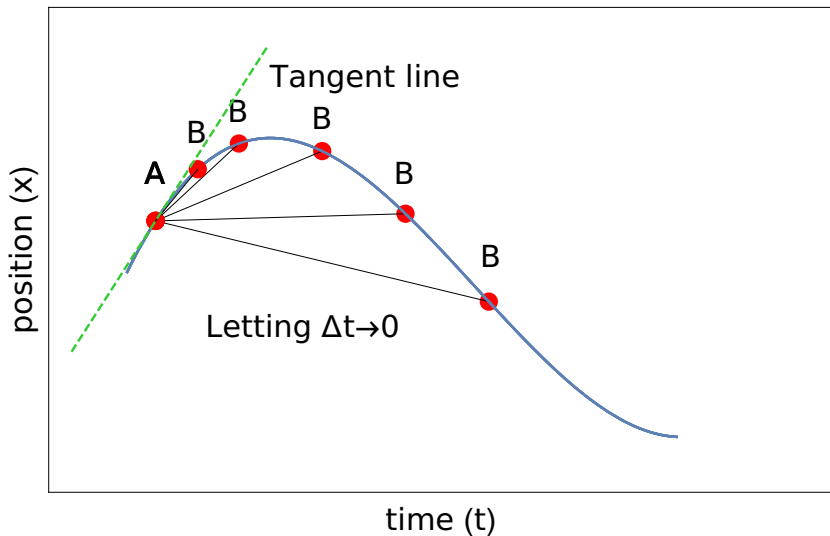
Horizontal distance to center of basket:  $22 \text{ m}$   
Basket height:  $3.10 \text{ m}$   
Basket diameter:  $0.46 \text{ m}$   
Ball diameter:  $0.239 \text{ m}$

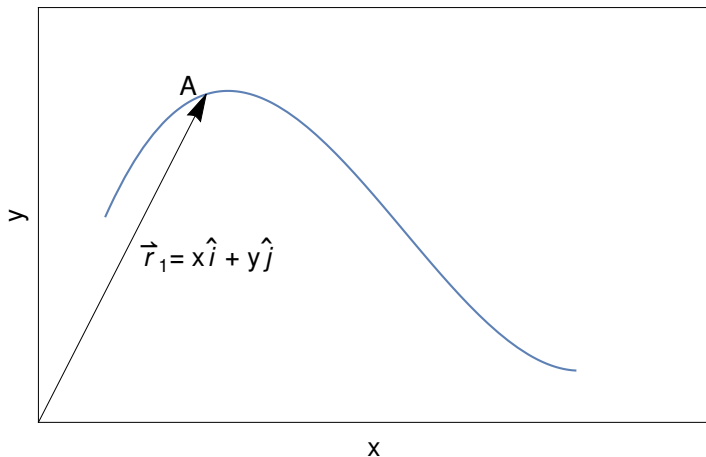


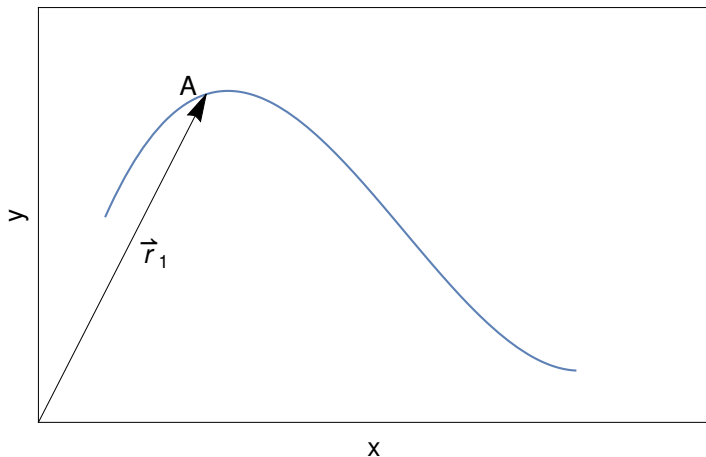
# Turning Around 1

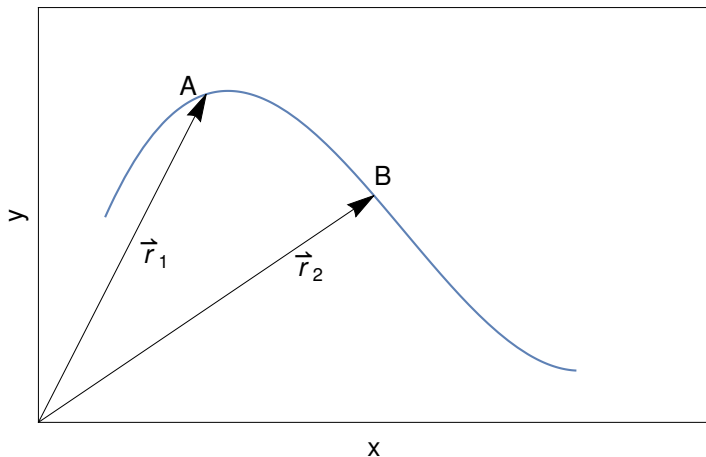
3

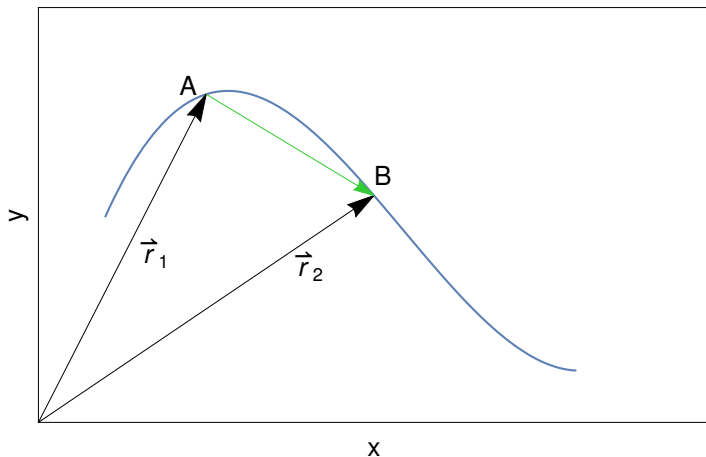




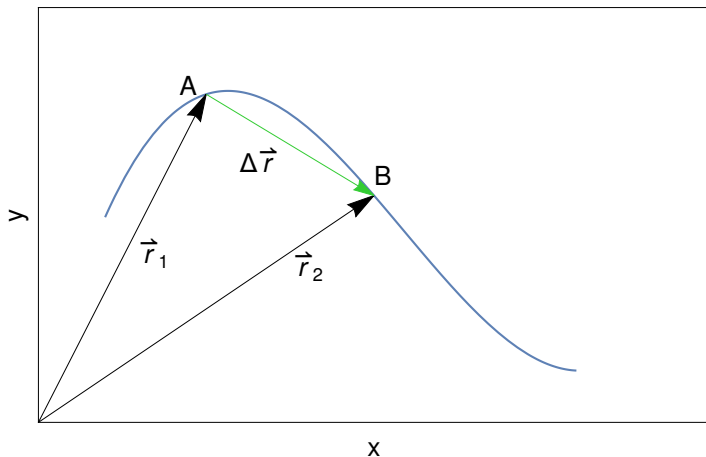


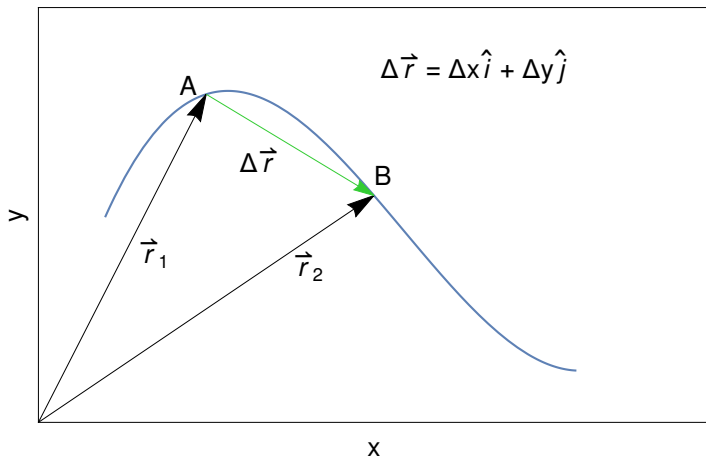


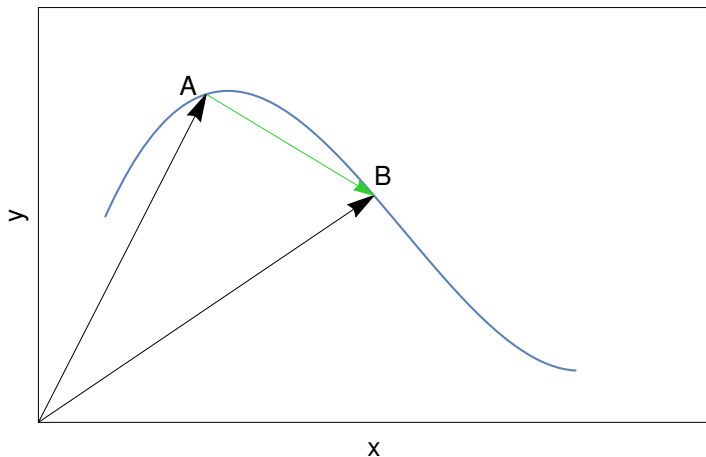


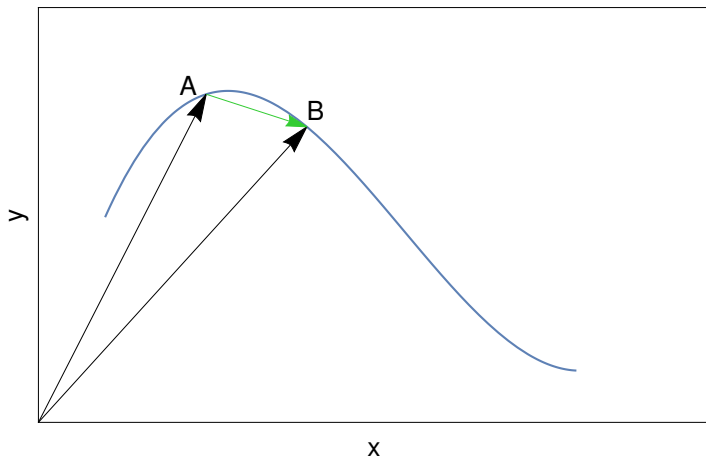


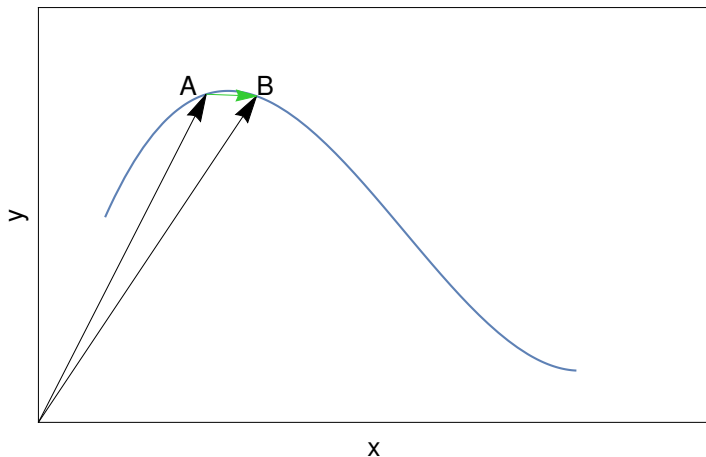


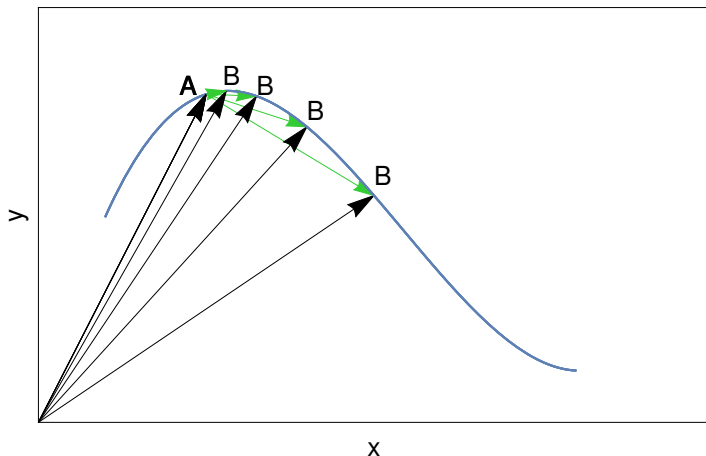


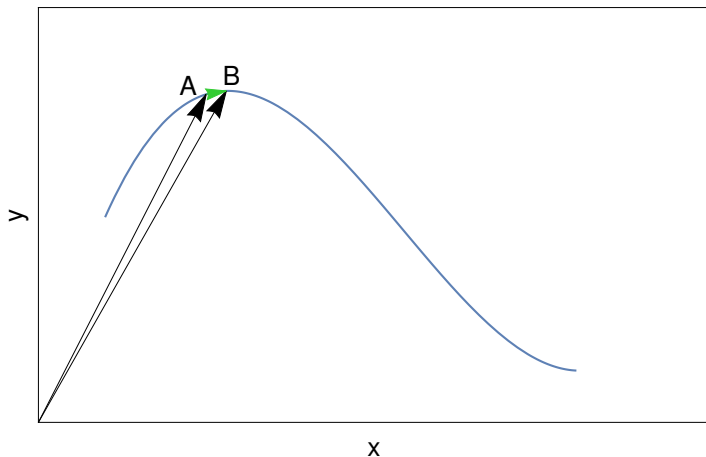


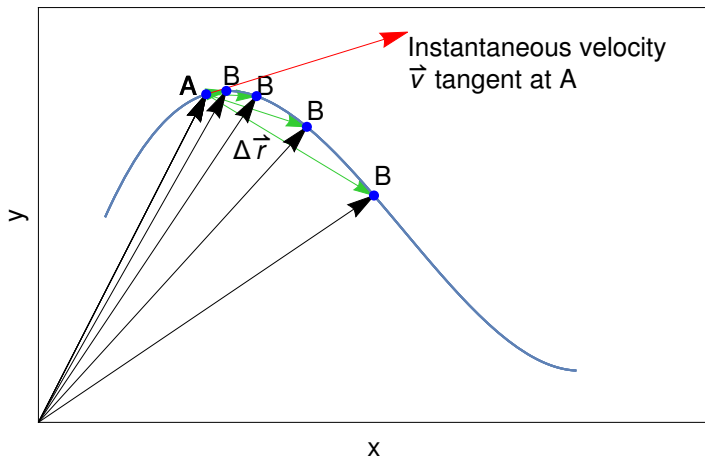




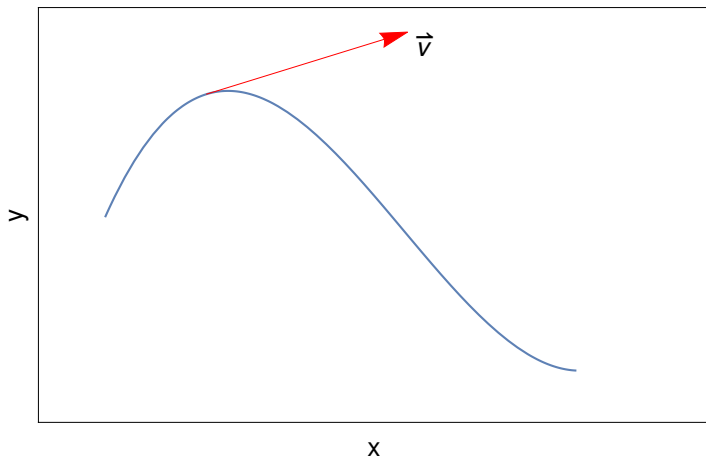




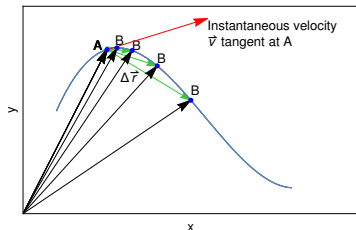
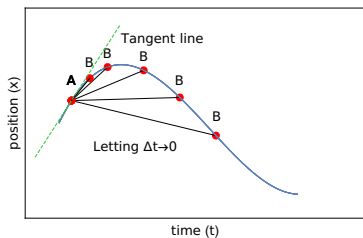


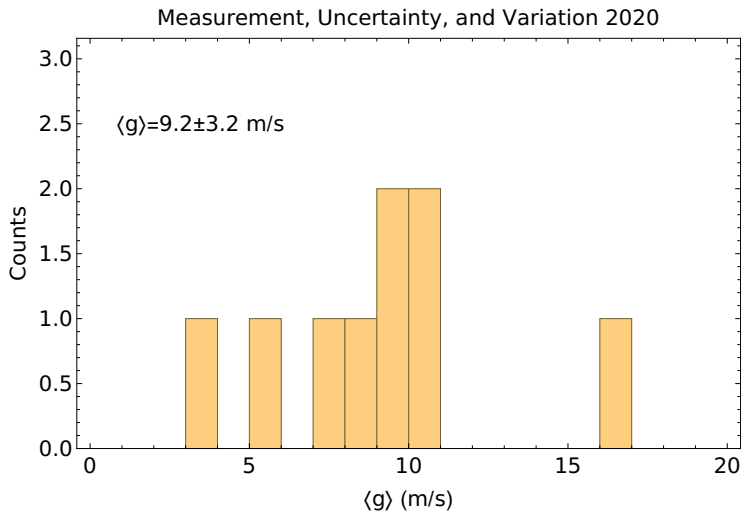






We'll use these plots to visualize and analyze motion, but they represent different quantities.





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  $54 \text{ m/s}$  (121 mph). If the height of the projectile at launch is  $y_0 = 20 \text{ m}$  and the launch angle is  $\theta = 30^\circ$ , then how far does it go before it lands? Assume there is no air friction and the ground is flat.

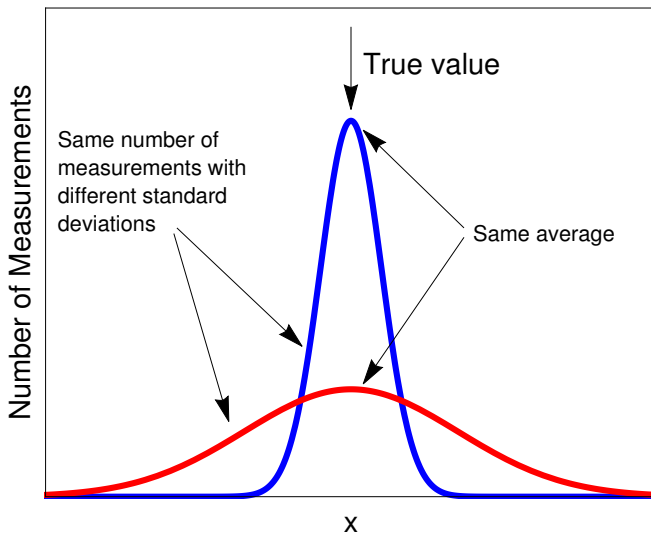


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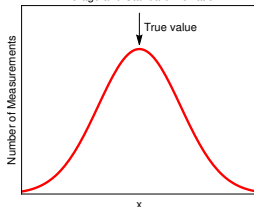
## Average and Standard Deviation





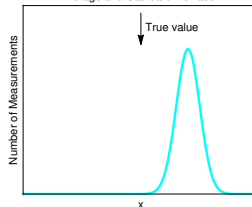
Not precise.

Average and Standard Deviation



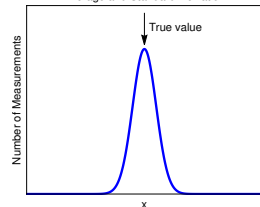
Precise, but not accurate.

Average and Standard Deviation

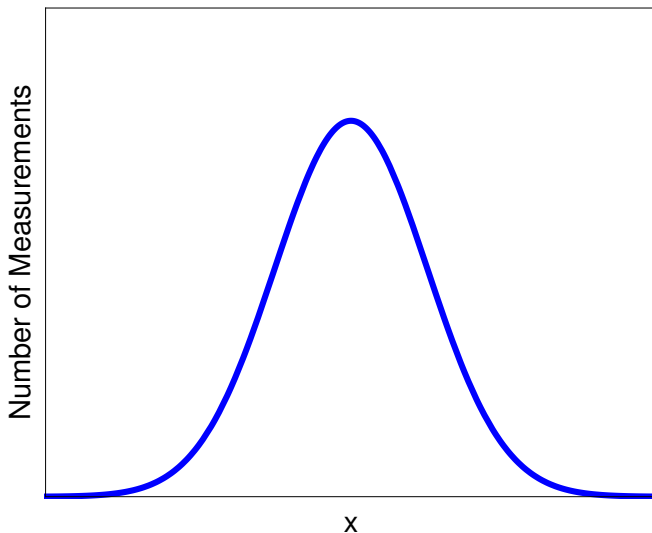


Precise and accurate.

Average and Standard Deviation

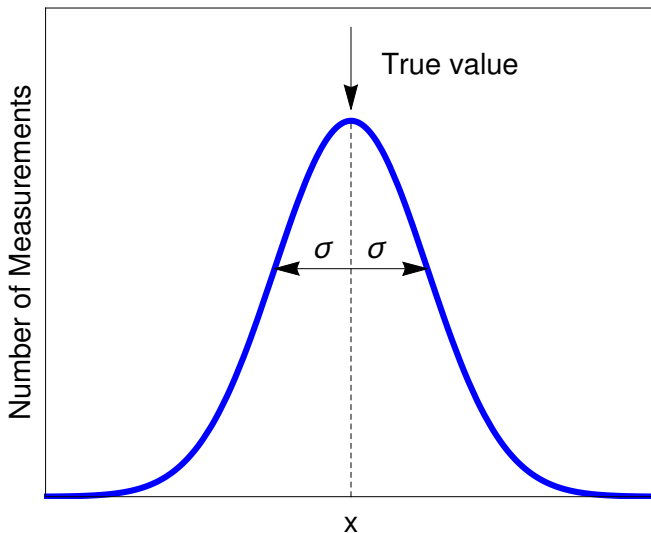


## Average and Standard Deviation

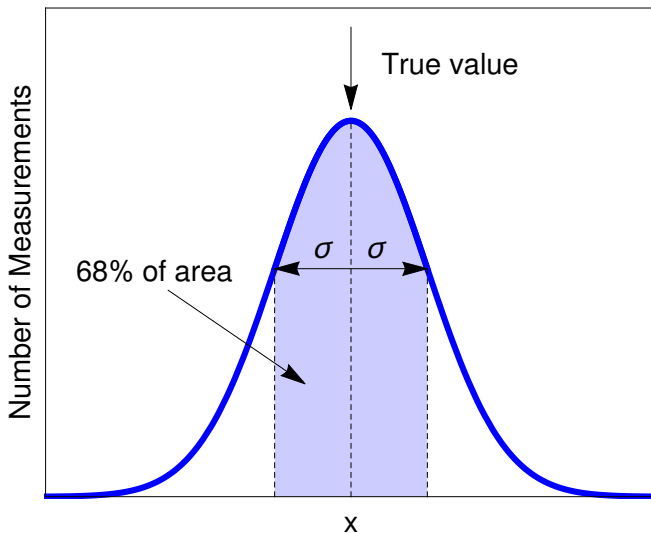




## Average and Standard Deviation



## Average and Standard Deviation



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
$11.2 \pm 0.9$	$11.7 \pm 1.5$

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
$11.4 \pm 1.4$	$11.7 \pm 1.5$