It’s Ain’t Over Till It’s Over!

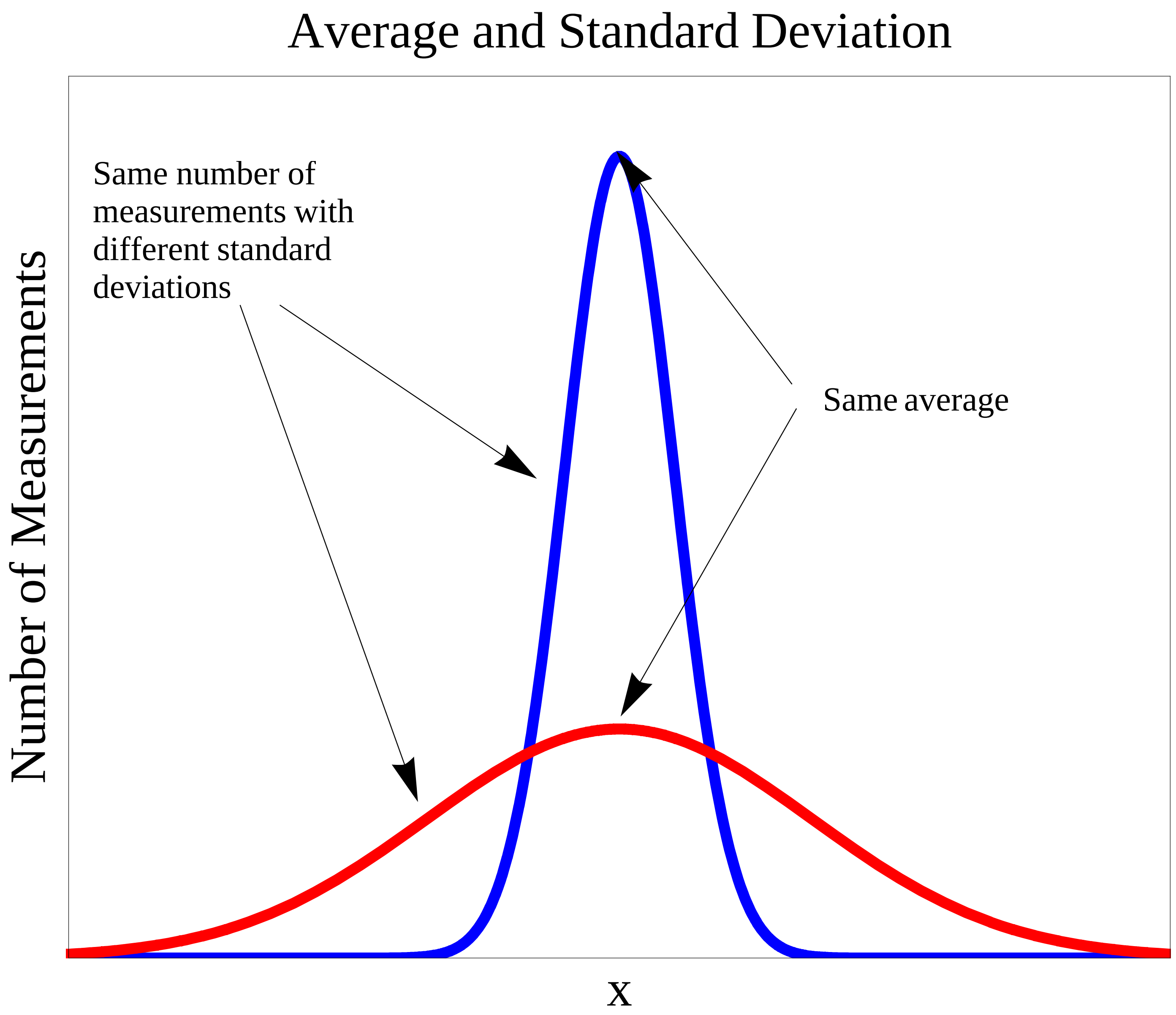
On January 31, 2005 Randolph-Macon College (RMC) was playing Guilford College in basketball at Randolph-Macon in Ashland, Virginia. The teams are tied 88-88 with just a fraction of a second in overtime. RMC in yellow sinks a free throw to win the game (at least they thought they won). The second free 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?

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.

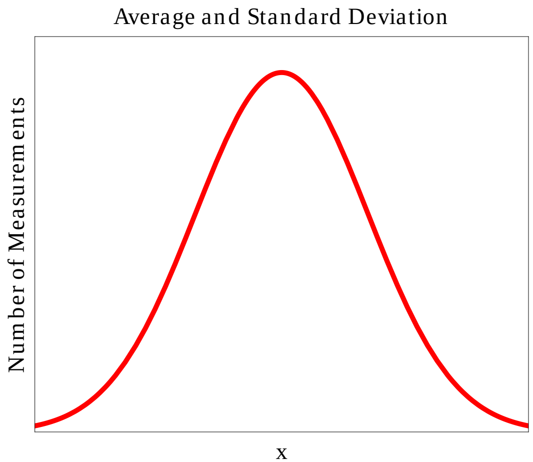
Horizontal distance to center of basket:	$22\ m$
Basket height:	$3.10\ m$
Diameter of basket:	$0.46\ m$
Diameter of ball:	$0.239\ m$

Measurement and Uncertainty

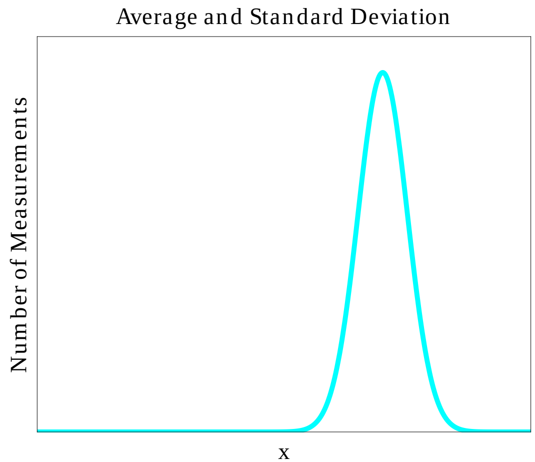


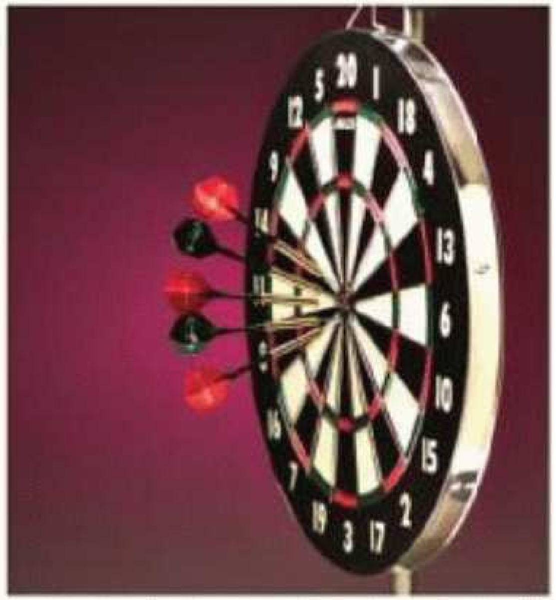
Precision versus Accuracy

Not precise.

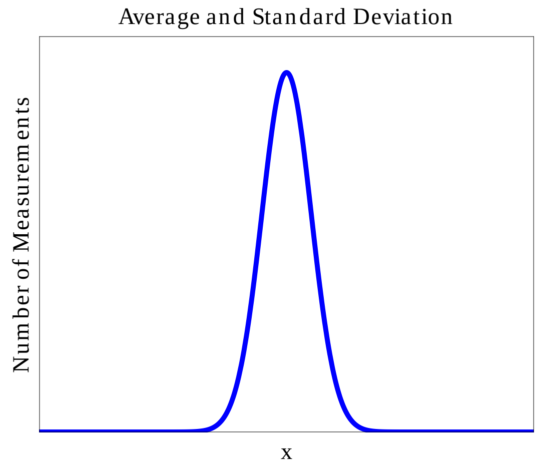


Precise, but not accurate.





Precise and accurate.

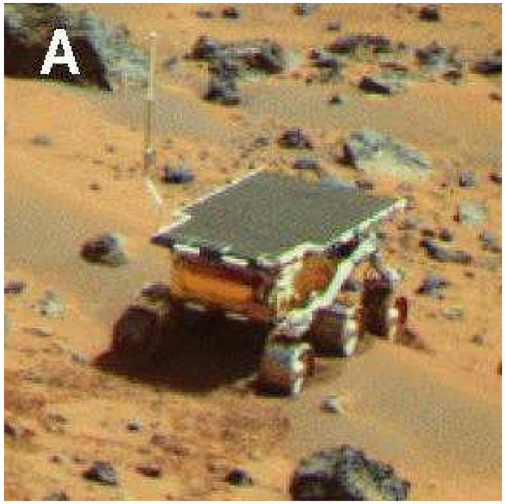


Mars Rovers

Three rovers are now on Mars and one (Opportunity) continues to transmit data back to Earth. Here we explore the unique method of these missions for landing on Mars.

The Bounce!

Sojourner

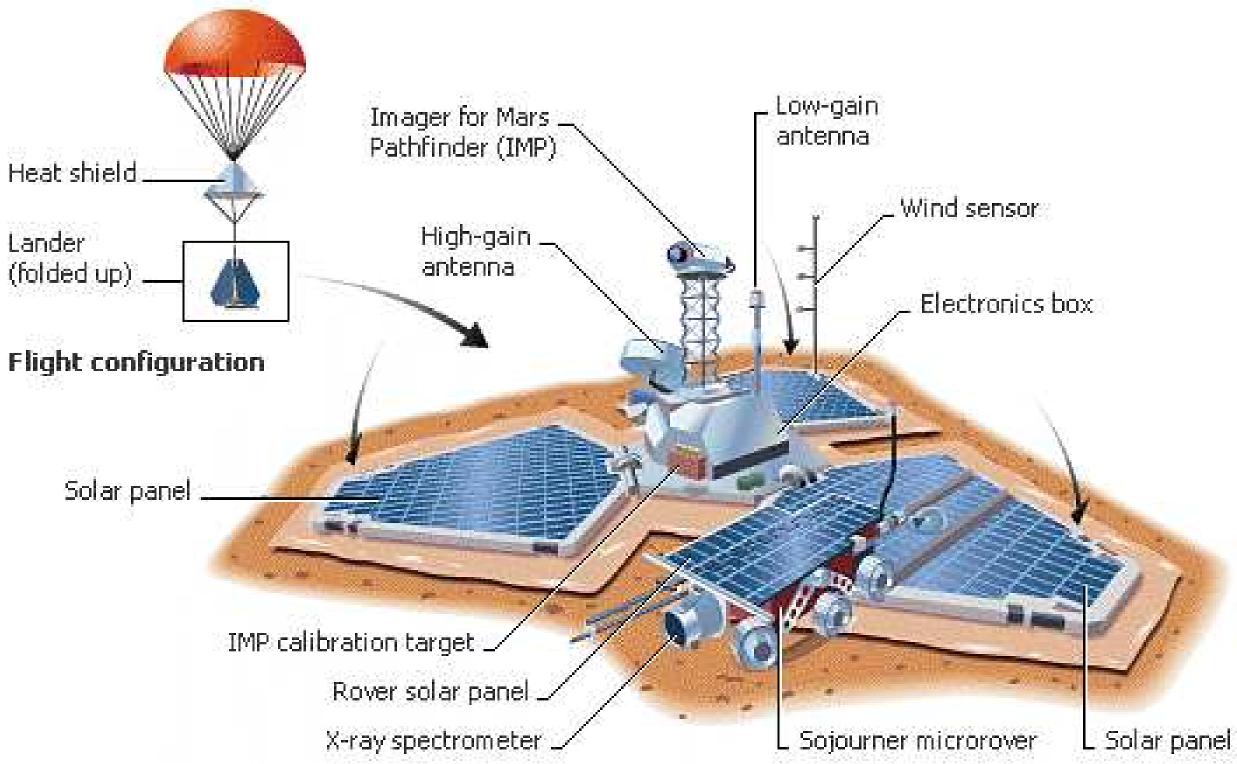


Spirit

Descent, and Egress

To save cost and weight the Mars rovers used a unique combination of parachutes, rockets, and airbags to cushion the landing on Mars.

The petals unfold.



Descent, and Egress

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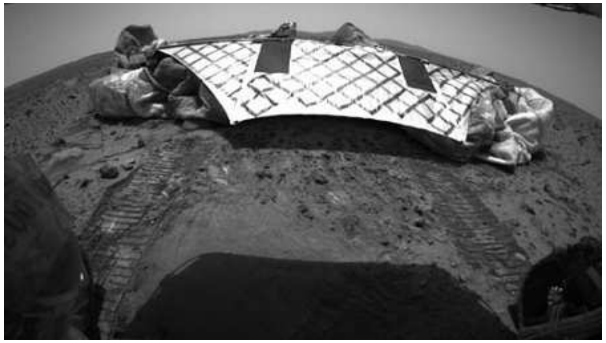
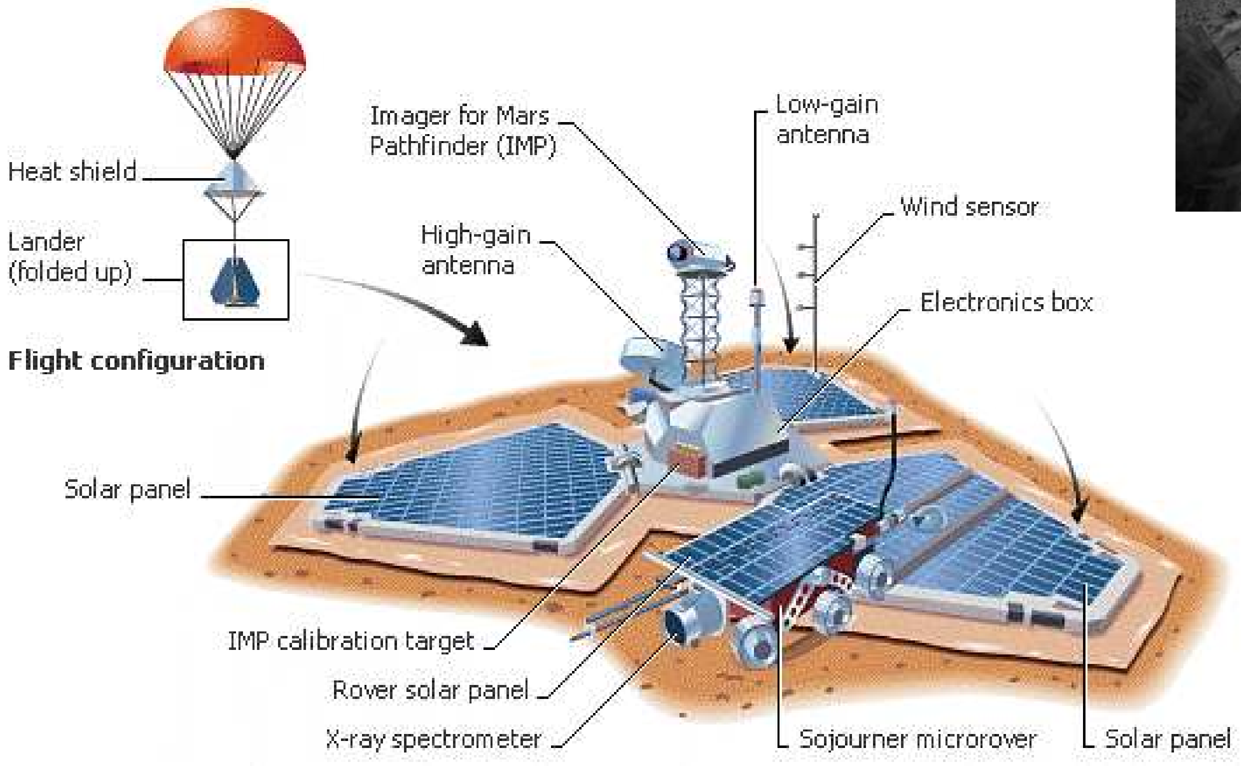
Looking back from Spirit!



The petals unfold.



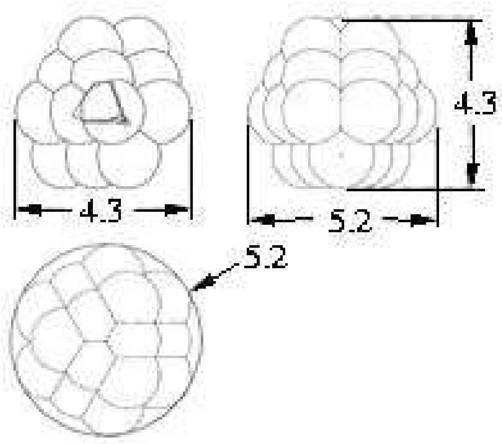
Bumpy Landing

On July 4, 1997 the Mars rover spacecraft landed in the Ares Vallis region of Mars. It used parachutes, small rockets, and airbags instead of the conventional, rocket-powered landing. The airbags were lighter and cheaper than rockets, but it meant Pathfinder bounced when it landed. It landed with a vertical velocity of about $12.5\ m/s$. How high did Pathfinder bounce? Assume the acceleration created by the compression of the airbags is a_1. When the bag rebounds the magnitude of the acceleration a_2 will be lower than during compression because some of the initial velocity and energy has been lost due to friction, gas leakage out of the bag, *etc.*. Assume the bag rebounds to its full size. Some useful parameters are listed below. Would this be an acceptable way for astronauts to land? Why? How would you test the validity of the model?

$a_1 = 170\ m/s^2 \qquad a_2 = 120\ m/s^2 \qquad g_{Mars} = 3.8\ m/s^2$

$R_{bag} = 0.9\ m \qquad m_p = 274.5\ kg$

The Twin Peaks in Ares Vallis.



The airbags.

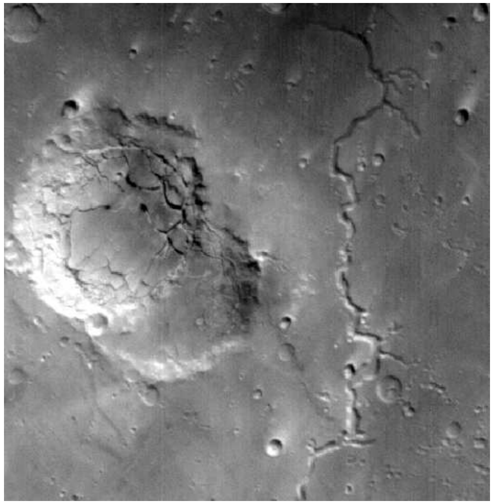
A NASA Nightmare

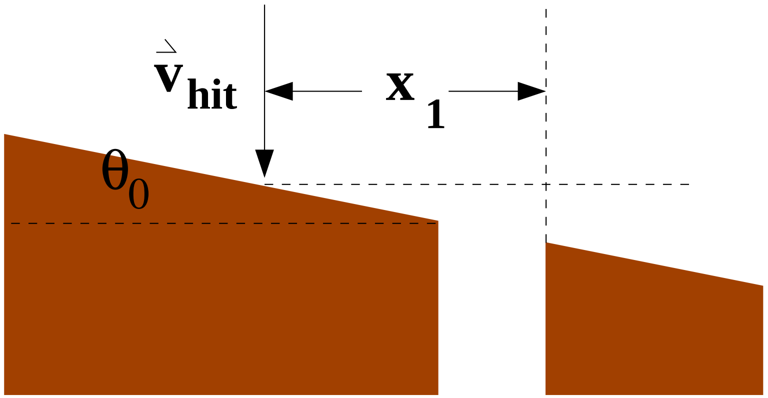
A new Mars probe is falling vertically when it lands with a vertical velocity of about $12.5\ m/s$ on a steep, $\theta_0 = 20°$, slope. The problem is that it has landed near a narrow gorge like the one in the photo below and if it falls into the gorge it will be unable to communicate with the orbiter and will be lost. The geography of the area is shown in the figure on the right-hand side. Some useful parameters are listed below. What was the angle of its velocity to the horizontal immediately after the bounce? Does the lander end up in the gorge?

$$m_{lander} = 274.5\ kg$$

$$g_{Mars} = 3.8\ m/s^2$$

$$x_1 = 53\ m$$





The Gorge of Death