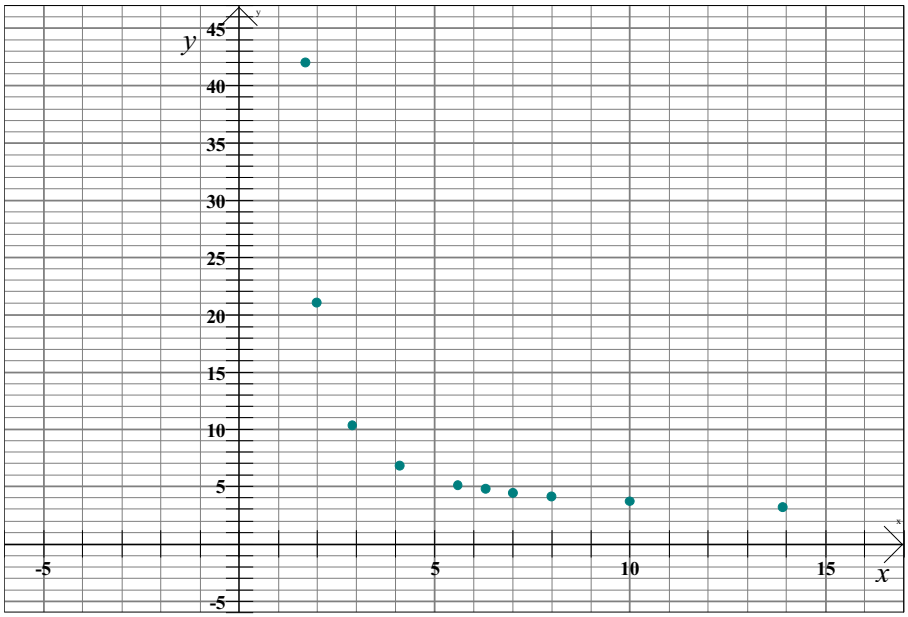
April 22, 2008

A murder of crows gathers different sizes of nuts. Crows love to eat nuts, but their beaks are not strong enough to crack open some of the shells of these nuts. In order to crack open the shells, they repeatedly drop the nut on a hard surface until it finally opens.

The following table shows the average number of drops it takes to break open a ***large*** nut from varying heights.

Height of Drop (m)	1.7	2.0	2.9	4.1	5.6	6.3	7.0	8.0	10.0	13.9
Number of Drops	42.0	21.0	10.3	6.8	5.1	4.8	4.4	4.1	3.7	3.2

Scatter Plot of the Effect of Dropping Large Nuts at Varying Heights on the Number of Drops It Takes to Crack It Open



where x = Height of Drop (m); $x > 0$ and y = Number of Drops

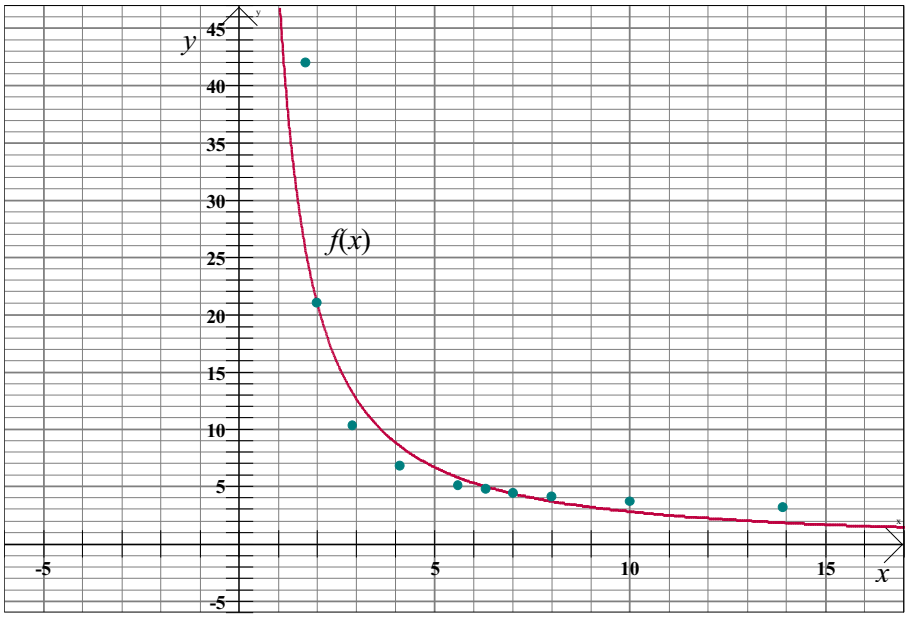
The graph models the behavior of a power regression.

Finding the equation algebraically (large nuts)

Power regression formula: $f(x) = ax^b$ where $x > 0$

Select two points: (2.0, 21.0) and (7.0, 4.4)
For each equation, solve for a: l(21.0) = a(2.0)^b l(4.4) = a(7.0)^b
a = 21.0/2.0^b a = 4.4/7.0^b
Use the transitive property: a = a, therefore 21.0/2.0^b = 4.4/7.0^b
Solve for b: 21.0/2.0^b = 4.4/7.0^b
7.0^b/2/0^b = 4.4/21.0
(7.0/2.0)^b = 4.4/21.0
$b$log(7.0/2.0) = log(4.4/21.0)
b = log(4.4/21.0)/log(7.0/2.0)
b ≈ -1.25
Substitute b to solve for a: a = 21.0/2.0^-1.25
a ≈ 49.9
Equation: $f(x)$ = 49.9x^-1.25

Scatter Plot of the Effect of Dropping Large Nuts at Varying Heights
on the Number of Drops It Takes to Crack It Open and the Line $f(x)$ = 49.9x^-1.25



where x = Height of Drop (m); x > 0 and y = Number of Drops
The parameters are a and b.

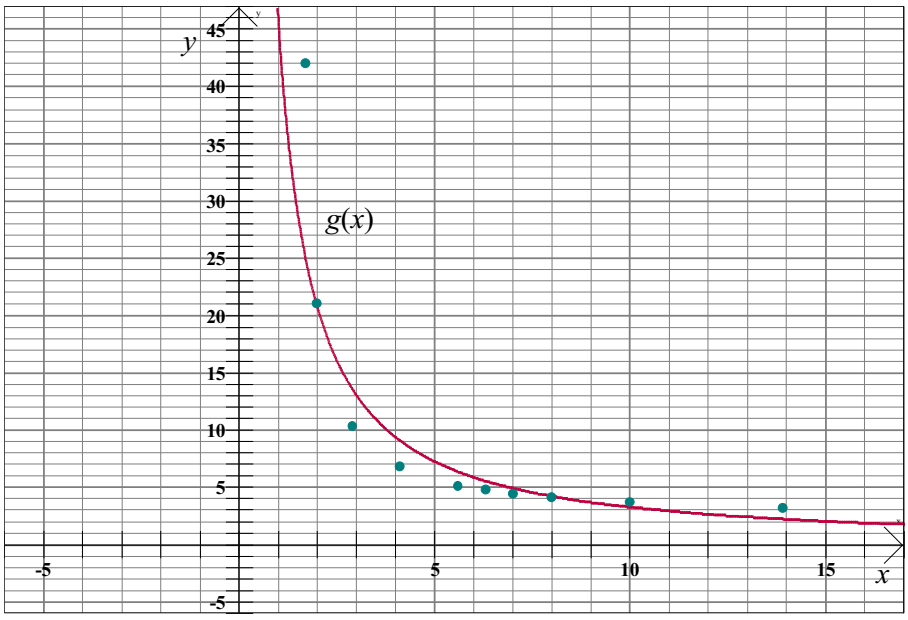
The choice of ordered pairs was randomly selected. The line $f(x)$ does not go through all points, but it does go through some making it a line of best fit.

<u>Finding the equation using a graphing calculator (large nuts)</u>

1. Hit the **STAT** button. Select **1: Edit**. To clear the lists, move the cursor to the top of the column until the heading is highlighted and press **CLEAR**, then **ENTER**. Enter the data for the "Height of Drop (m)" in **L1** and the data for the "Number of Drops" in **L2**.
2. Hit **2nd**, then **STAT PLOT**. Press **1**. Move the cursor to **On** and select it by pressing **ENTER**. Move the cursor to the line labeled **Type**. The first icon represents a scatter plot. Select the **scatter plot type** and press **ENTER**. Move the cursor to the line labeled **Xlist** and press **2nd**, then **LIST** and select **L1** to enter it as the variable *x*. Move the cursor to the line labeled **Ylist** and press **2nd**, then **LIST** and select **L2** to enter it as the variable *y*. Move the cursor to the line labeled **Mark** and press **ENTER** to select the first icon. This is the mark that will be used for each point in the scatter plot.
3. Hit **GRAPH** to display the scatter plot.
4. Return to and clear the home screen by pressing **2nd**, **QUIT**, and then **CLEAR**. Hit the **STAT** button, move the cursor to **CALC**, and press **ENTER**. Move the cursor down to find **PwrReg** and select it by pressing **ENTER**. Hit **ENTER** again to receive the values for *a* and *b*.

Equation: $g(x) = 46.1x^{-1.15}$

Scatter Plot of the Effect of Dropping Large Nuts at Varying Heights
on the Number of Drops It Takes to Crack It Open and the Line $g(x) = 46.1x^{-1.15}$

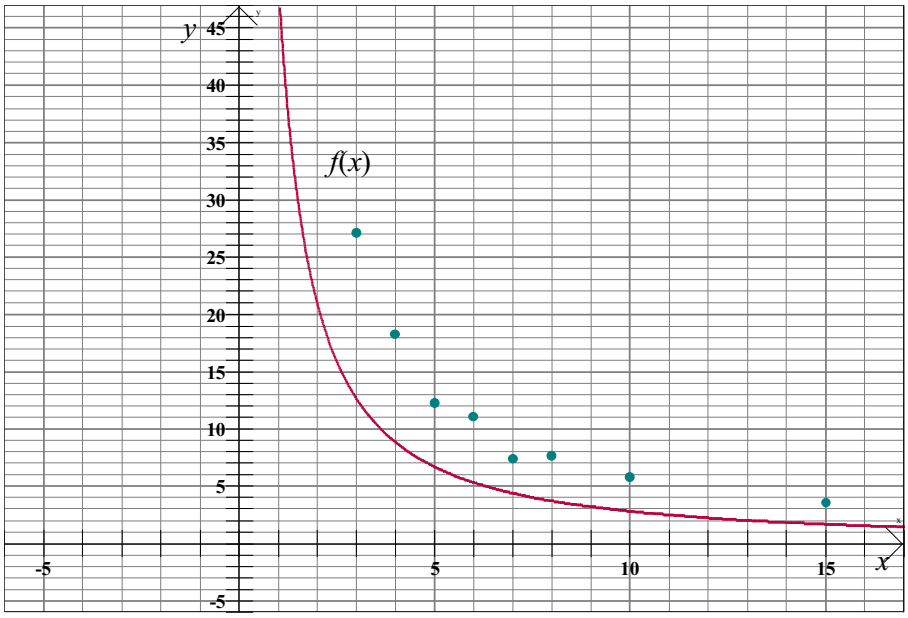


where x = Height of Drop (m); $x > 0$ and y = Number of Drops
The parameters are a and b.

The line $g(x)$ is slightly different from the line $f(x)$. The line $f(x)$ however, does go through more points than does the line $g(x)$.
The following table shows the average number of drops it takes to break open a ***medium*** nut from varying heights.

Height of Drop (m)	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	10.0	15.0
Number of Drops	-	-	27.1	18.3	12.2	11.1	7.4	7.6	5.8	3.6

Scatter Plot of the Effect of Dropping Medium Nuts at Varying Heights
on the Number of Drops It Takes to Crack It Open and the Line $f(x) = 49.9x^{-1.25}$



where x = Height of Drop (m); $x > 0$ and y = Number of Drops
The parameters are a and b.

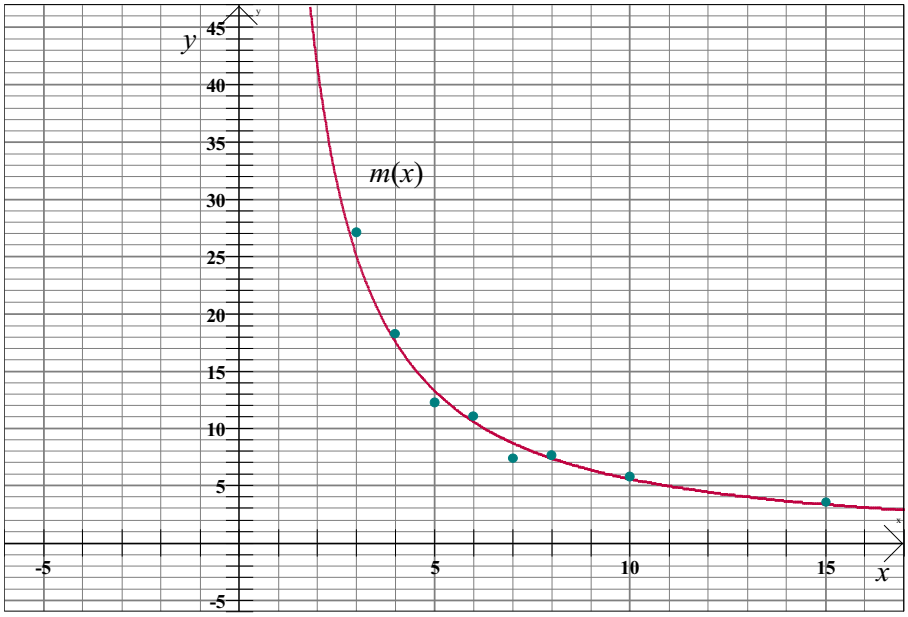
The line $f(x)$ does not apply to the scatter plot of medium nuts. The data points are above the line $f(x)$. A change needs be made to this line. The value of a must be significantly increased.

Finding the equation using a graphing calculator (medium nuts)

For steps, see "Finding the equation using a graphing calculator (large nuts)." Apply data medium nuts in place of the large nuts.

Equation: $m(x) = 99.1x^{-1.25}$

Scatter Plot of the Effect of Dropping Medium Nuts at Varying Heights
on the Number of Drops It Takes to Crack It Open and the Line $m(x) = 99.1x^{-1.25}$



where x = Height of Drop (m); $x > 0$ and y = Number of Drops
The parameters are a and b.

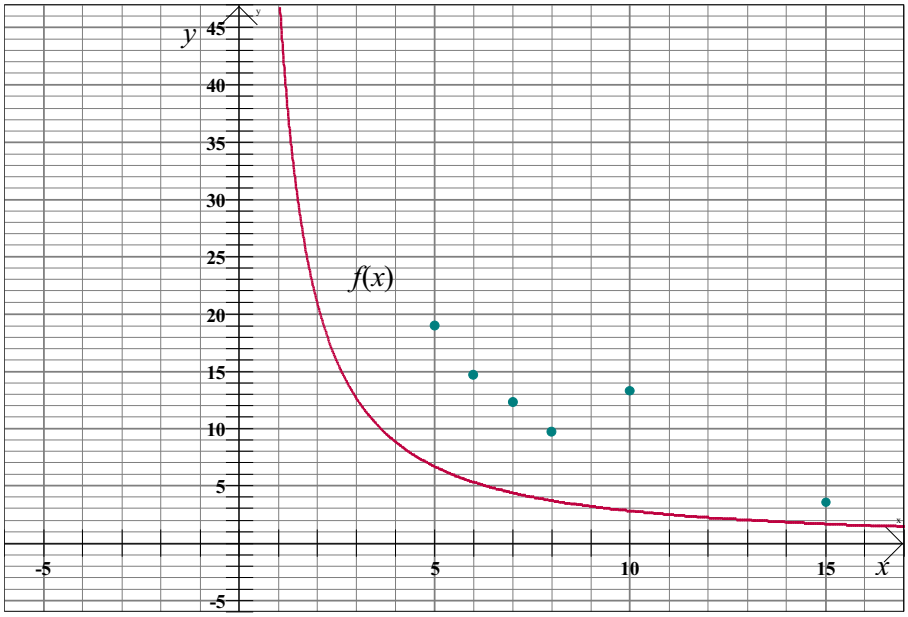
This equation fits much better than $f(x)$.

The following table shows the average number of drops it takes to break open a ***small*** nut

from varying heights.

Height of Drop (m)	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	10.0	15.0
Number of Drops	-	-	-	57.0	19.0	14.7	12.3	9.7	13.3	9.5

Scatter Plot of the Effect of Dropping Small Nuts at Varying Heights
on the Number of Drops It Takes to Crack It Open and the Line $f(x) = 49.9x^{-1.25}$



where x = Height of Drop (m); $x > 0$ and y = Number of Drops
The parameters are a and b.

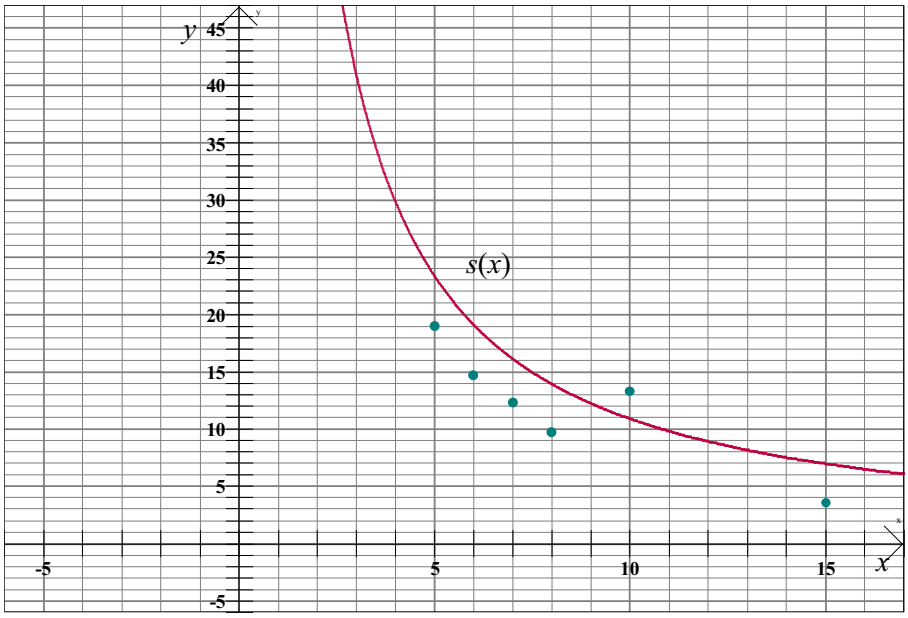
The line $f(x)$ also does not apply to the scatter plot of small nuts. The data points again are above the line $f(x)$. The change needs be made to this line. The value of a must be significantly increased and b may have to be slightly increased.

Finding the equation using a graphing calculator (medium nuts)

For steps, see "Finding the equation using a graphing calculator (large nuts)." Apply data small nuts in place of the large nuts.

Equation: $s(x) = 137x^{-1.10}$

Scatter Plot of the Effect of Dropping Small Nuts at Varying Heights
on the Number of Drops It Takes to Crack It Open and the Line $s(x) = 137x^{-1.10}$



where x = Height of Drop (m); $x > 0$ and y = Number of Drops
The parameters are a and b.

This graph fits much better than $f(x)$.