ICE - Power Functions

Figure 1a: The nucleus of Comet Halley imaged by "Giotto" in 1986.

One of the great triumphs of Sir Isaac Newton's scientific career was his successful prediction of the return of Halley's comet (see Figure 1(a)[1] in 1682[2]. Newton was so highly respected for his contributions to mathematics and science that he was laid to rest in Westminster Abbey (one of England's holiest and most revered sites - see Figure 1[3]).

In order to predict the return of Comet Halley, Newton had to relate the time that it took the comet to travel once around the sun to astronomical observations. In this activity, you will replicate some of Newton's analysis.

Figure 1b: Sir Isaac Newton's memorial in Westminster Abbey, London, England.

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[1] Image source: European Space Agency.

[2] Source: Halliday, D., Resnick, R. and Walker, J. (1997) "Fundamentals of Physics. Fifth Edition." New York: John Wiley and Sons.

[3] Image source: http://www.westminster-abbey.org/

Table 1[4] gives the astronomical data for the inner planets[5] of the solar system.

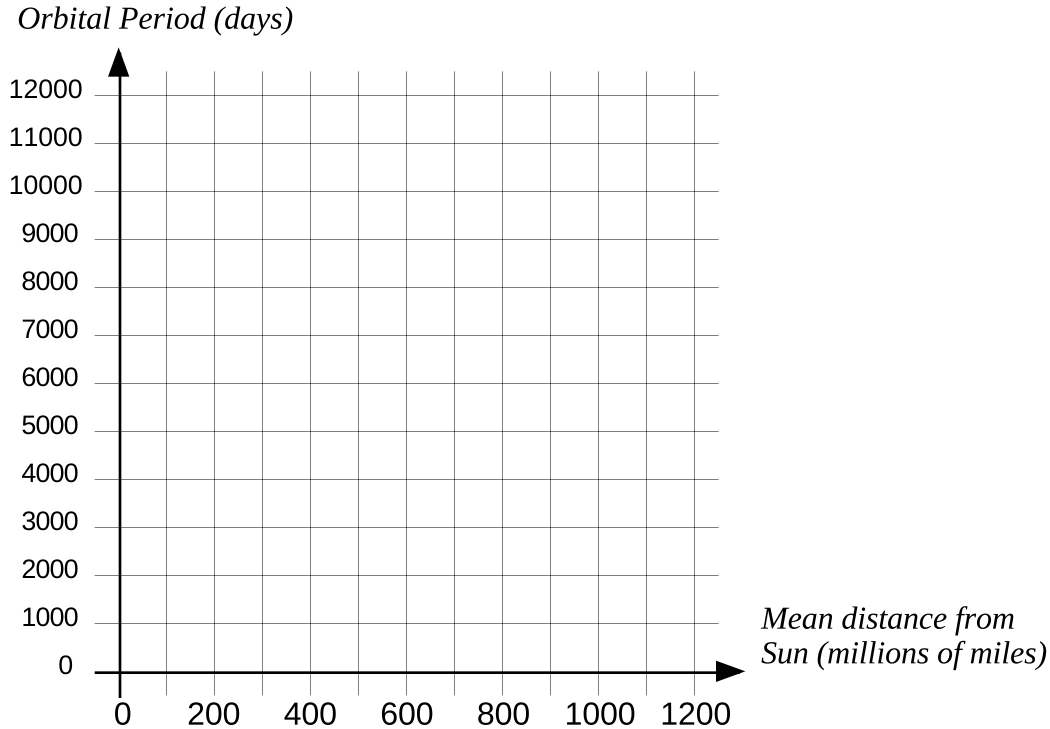
Planet	Image	Mean distance from Sun (millions of miles)	Orbital period (days)
Mercury		36	88
Venus		67	225
Earth		93	365
Mars		142	687
Jupiter		484	4333
Saturn		866	10759

Table 1: Planetary Data.

[4] The data and images included in Table 1 are courtesy of NASA and the Jet Propulsion Laboratory of Pasadena, CA.

[5] The inner planets are Mercury, Venus, Earth, Mars, Jupiter and Saturn. The outer planets are Uranus, Neptune and Pluto.

- ***Use the axes given below to plot the data from Table 1.***



- ***Based on the appearance of your plot, what kind of function might do a good job of relating the orbital period to the distance from the sun?***

- ***Test your hypothesis by using your calculator to find an equation for your function.***

The planet Pluto (see Figure 3[6]) was discovered in 1930 by astronomer Clyde Tombaugh[7] (1907-1997). Pluto's average distance from the sun is about 3660 million miles, and it takes 90591 days to travel once around the sun.

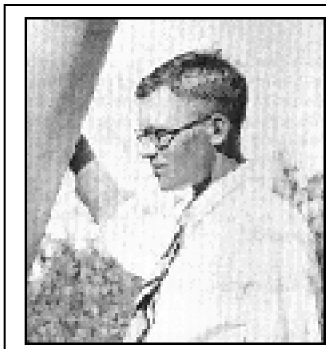


Figure 2: Astronomer Clyde Tombaugh.

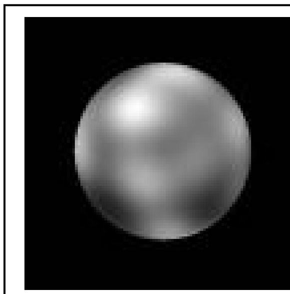


Figure 3: Image of Pluto from the Hubble Space Telescope.

[6] This image was produced by the Hubble Space Telescope in 1996. Image source: Jet Propulsion Laboratory Planetary Photojournal.

[7] Image source: http://www.jpl..nasa.gov/

• ***Does the equation you have found predict the orbital period of Pluto accurately?***

• ***If you distance was 0 miles (i.e. you are right at the center of the Sun), how much time would you expect a journey around the center point of the Sun to take? How would this change your ideas about the "best" function to use in this situation?***

The process outlined in Figure 4 shows one method for using a graphing calculator to fit a power function:

$$y = k \cdot x^n.$$

to a given set of data.

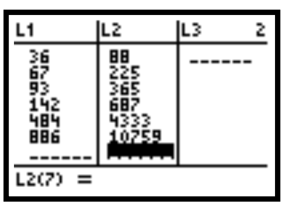


Figure 4a: Enter the data into lists.

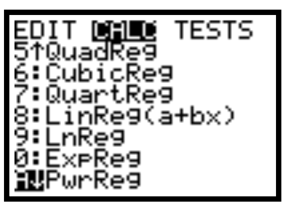


Figure 4b: Press the [STAT] key and select the CALC menu. Choose the PWRREG option.

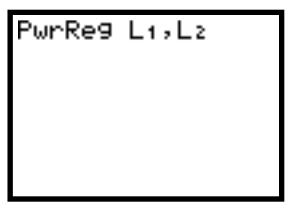


Figure 4c: Tell the calculator which lists you have entered data into and execute the command.

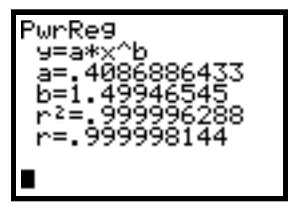


Figure 4d: If you have done everything correctly, then you should end up with a screen like this.

• ***Use your calculator to find the equation for a power function using the data in Table 1.***

• ***Use the power function you have found to predict the orbital period of Pluto. Does this prediction agree with the measured value of 90591 days?***