Eye Spy – The Distant, Cold Bodies of the Solar System

Get the Data

Visit EOSS **http://1.usa.gov/GAZjGS** to recreate this exact scene. Recommended Operating System: MS Vista or later; Web Browser: MS Internet Explorer 8 or later.

Right-click on the label for the sun and select 'Measure Distance From' from the menu. Left-click on the label for Saturn and note the 'Sun-Saturn' distance. Right-click on the label for the sun and then click on the label for Uranus, noting the distance. Repeat this sequence to obtain the distances to the dwarf planets Makemake and Sedna. The formula for estimating the temperature (in Kelvins) of a dark body at a distance of D (in billions of kilometers) from the sun is given by

$$T = \frac{100}{\sqrt{D}}$$

Answering Questions

Problem 1 – What is the surface temperature of the minor planet Sedna on the Fahrenheit scale?

Problem 2 - What is the temperature of Saturn at the top of its atmosphere according to the Celsius scale?

Problem 3 – For which pair of objects is the temperature difference close to 20 Celsius?

Math Challenge

As Halley's Comet orbits the sun, what is the temperature range, in Fahrenheit, of its surface?

Answer Key

Problem 1 – What is the surface temperature of the minor planet Sedna on the Fahrenheit scale? Answer: Sedna is at a distance of about 8 billion miles or 12.9 billion km, so from the formula $T = 100/\sqrt{12.9} = 27.8$ K. Converting to Celsius we get C = 27.8 – 273 = -245 C, then for Fahrenheit we use F = 9/5(C) + 32 to get **T = -473 F**.

Problem 2 - What is the temperature of Saturn at the top of its atmosphere according to the Celsius scale? Answer: Saturn's distance from the sun is about 0.9 billion miles or 1.5 billion km, so $T = 100 / \sqrt{1.5}$ so T = 82 K. To convert to Celsius we subtract 273 to get **T = -191 C**.

Problem 3 – For which pair of objects is the absolute temperature difference closest to 20 Celsius? Answer: The distances are Sun-Uranus = 3.0 billion km; Sun-Saturn = 1.5 billion km; Sun-Makemake= 7.8 billion km and Sun-Sedna = 12.9 billion km. The temperatures are: Saturn = -191 C; Uranus = -215 C; Makemake = -237 C and Sedna = -245 C. The table below shows the possible differences. The answer is Uranus to Makemake.

	Saturn	Uranus	Makemake	Sedna
Saturn	0	24	46	54
Uranus	24	0	22	30
Makemake	46	22	0	8
Sedna	54	30	8	0

As Halley's Comet orbits the sun, what is the temperature range, in Fahrenheit, of its surface?

At its farthest distance (aphelion) around the year 2025, it is located about 5.25 billion km from the sun while at its closest distance (perihelion: 1986) it was about 131 million kilometers from the sun. From the formula, the temperature of the comets surface was aphelion Ta = 44 K; perihelion Tp = 276 K. First convert to Celsius to get Ta = -229 C, and Tp = +3.0 C. Then convert to Fahrenheit using F = 9/5 (C) + 32 to get **Ta = -380 F and Tp = +37 F.**