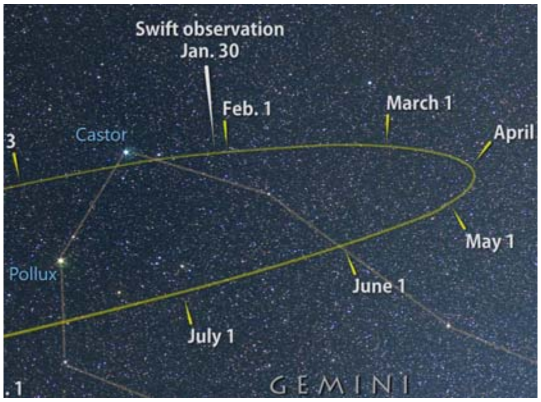
The Orbit of Comet ISON



Comet ISON will be carefully watched as it makes its closest approach to the sun in November, 2013. Some astronomers predict that it may break up into smaller comets because of the Sun's enormous gravity. The comet will travel to within 1,800,000 km of the center of the sun, or about 1,100,000 km from the hot solar surface! As it travels, it will also get very close to Mars and the asteroid 3362 Khufu, though no impacts are predicted!

A portion of its track across the sky is shown in the figure for January-July, 2013.

The table below gives the location of Comet ISON as it approaches the sun. The sun is located at the point (-0.4, +14.7) where all of the coordinate units are in millions of kilometers.

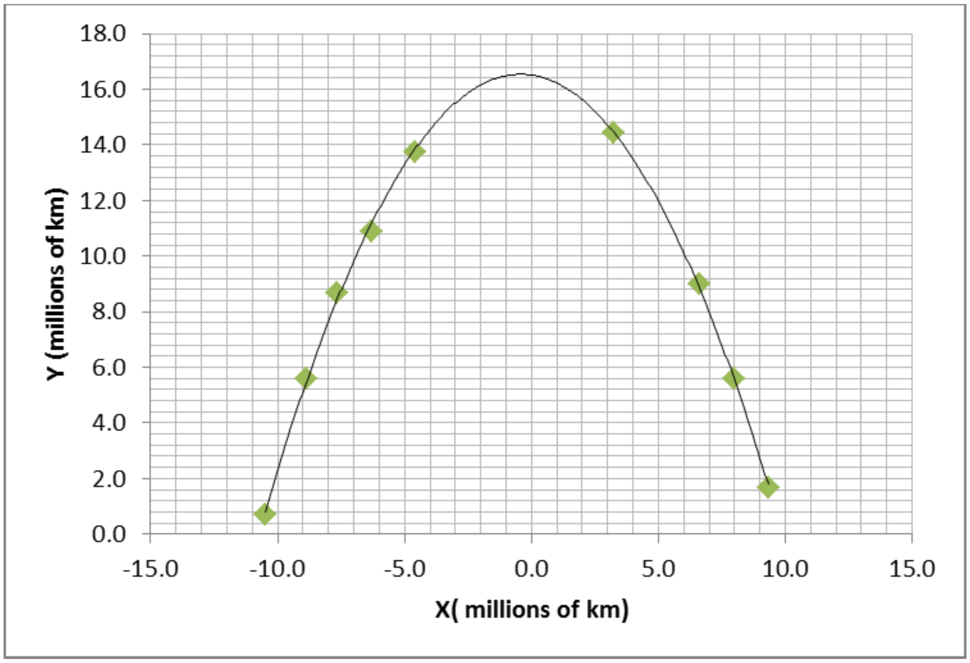
Date and Universal Time	X (million km)	Y (million km)	Distance to the sun (million km)
November 26, 18:00 UT	-10.5	+0.7	
November 27, 13:00 UT	-8.8	+5.6	
November 28, 01:00 UT	-7.7	+8.7	
November 28, 08:00 UT	-6.3	+10.9	
November 28, 14:00 UT	-4.6	+13.7	
November 28, 23:00 UT	+3.2	+14.5	
November 29, 10:00 UT	+6.6	+9.0	
November 29, 19:00 UT	+8.0	+5.6	
November 30, 10:00 UT	+9.3	+1.7	

Problem 1 - Plot these points on an X-Y graph and connect the points with a smooth parabolic curve.

Problem 2 – Using either a millimeter ruler and the scale of the graph, or the Two Point Distance Formula, calculate the distance from each comet position to the sun in the table.

Problem 3 – What is your prediction for the time when Comet ISON is at its closest point in its orbit to the sun?

Problem 1 - Plot these points on an X-Y graph and connect the points with a smooth parabolic curve. **Note: These coordinates are valid for the orbit as known on November 24, 2013 but may change as a more precise orbit is eventually determined.**



Problem 2 – Using either a millimeter ruler and the scale of the graph, or the Two Point Distance Formula, calculate the distance from each comet position to the sun in the table. Answer: For advanced students using the distance formula: $D = ((x2-x1)^2 + (y2-y1)^2)^{1/2}$. For the x2 at (-10.5, +0.7) and x1 (sun) at (-0.4,+14.7) so D = 17.3 million km.

Date and Universal Time	X (million km)	Y (million km)	Distance to the sun (million km)
November 26, 18:00 UT	-10.5	+0.7	**17.3**
November 27, 13:00 UT	-8.8	+5.6	**12.4**
November 28, 01:00 UT	-7.7	+8.7	**9.4**
November 28, 08:00 UT	-6.3	+10.9	**7.0**
November 28, 14:00 UT	-4.6	+13.7	**4.3**
November 28, 23:00 UT	+3.2	+14.5	**3.6**
November 29, 10:00 UT	+6.6	+9.0	**9.1**
November 29, 19:00 UT	+8.0	+5.6	**12.4**
November 30, 10:00 UT	+9.3	+1.7	**16.3**

Problem 3 – What is your prediction for the exact time when Comet ISON is at its closest point in its orbit to the sun? Answer: Students may interpolate between Points 5, 6 and 7 using any convenient method. The answers should be close to **November 28 at 18:00 UT and a distance to the sun of about 1,840,000 km.**

Using Calculus: The best fit parabola is $y = -0.155X^2 - 0.132X + 16.51$. Setting the first derivative equal to zero we get $0 = -0.31X - 0.132$ so X= -0.43 and Y = +16.54. The distance to the sun is then 1.84 million km.