

# Dark Matter

1. From the graphic on the “But . . .” slide, how far away is the Sun from the galactic center in meters? ( 1 kpc =  $3.08 * 10^{19}$  m)
  
2. From the same graphic, what is the Sun orbital speed in meters per second? (1 km = 1,000 m)
  
3. What is the circumference of the circle the Sun traces out as it orbits the galactic center.  $C = 2\pi r$
  
4. How long does it take the Sun to orbit the galactic center in years? (1 year =  $3.16 * 10^7$  seconds)
  
5. The Sun is about 5 billion years old. How many times has it orbited about the center of the Milky Way?
  
6. In order for a galaxy to escape a cluster, its kinetic energy must be greater than the gravitational bond that attracts it to the cluster. Using the following equation, calculate the escape velocity of a galaxy in a typical cluster.

$$\frac{1}{2} m_{\text{galaxy}} v^2 = \frac{G m_{\text{cluster}} m_{\text{galaxy}}}{\text{distance to center of cluster}}$$

G	=	$6.67 * 10^{-11} \text{ Nm}^2/\text{kg}^2$
distance to the center of cluster	=	$2.31 * 10^{22} \text{ m}$
mass of cluster	=	$1.99 * 10^{45} \text{ kg}$