Activity #1 Name Answer Key Section 2 3
Distance Scales in the Universe

Speed of Light	$c = 3.00 \times 10^{10}$ cm/s	Radius of Earth	$R = 6.37 \times 10^{8}$ cm
Astronomical Unit	$1\ AU = 1.50 \times 10^{13}$ cm	Metric units	100 cm = 1 m
Parsec	$1\ pc = 3.09 \times 10^{18}$ cm		1000 m = 1 km
	1000 pc = 1 kpc	Year	3.16×10^{7} s
	1000 kpc = 1 Mpc		

1. How many centimeters are there in a light year (the distance light travels in one year)?
Please note that a light year is a unit of distance, and not of time!
Note: Distance = speed x time

1 light year = $(3\times10^{10}\ cm/s)(3.16\times10^{7}\ s) = \boxed{9.48\times10^{17}\ cm}$

2. How long would it take light to travel from the Earth to the Sun? The Astronomical Unit is defined as the mean Earth-Sun distance. Express your answer in units of time which make the number somewhere between 0.01 and 100.

$1\ AU = 1.5\times10^{13}\ cm\left(\frac{1\ ly}{9.48\times10^{17}\ cm}\right) = (1.58\times10^{-5}\ ly)\left(\frac{3.16\times10^{7}\ s}{1\ yr}\right)$

$= 500$ light seconds

It takes 500 seconds $\left(\frac{1\ min}{60\ sec}\right) = \boxed{8.3\ minutes}$

3. On average, how long would it take light to travel from the Sun to Pluto? The mean Sun-Pluto distance is 5.91×10^{9} km.

$(5.91\times10^{9}\ km)\left(\frac{1000\ m}{1\ km}\right)\left(\frac{100\ cm}{1\ m}\right)\left(\frac{1\ ly}{9.48\times10^{17}\ cm}\right) = 6.3\times10^{-4}\ ly$

It would take $(6.3\times10^{-4}\ yr)\left(\frac{365.24\ days}{yr}\right)\left(\frac{24\ hours}{1\ day}\right) = \boxed{5.46\ hours}$

4. One of the closest stars is Alpha Cen, with a distance of 4.3 light years. How long would it take light to travel from the Earth to Alpha Cen?

4.3 light years means that takes 4.3 years for the light to travel that distance. Therefore

4.3 years

5. The distance from the Sun to the center of the Milky Way galaxy is approximately 8.5 kpc, and very close to the plane of the Milky Way. How long does it take light from the center of the Galaxy to reach us?

$8.5\ kpc \left(\frac{3.26\ ly}{1\ pc}\right)\left(\frac{3.0\times10^{8}\ m}{1\ s}\right)\left(\frac{1\ ly}{9.5\times10^{15}\ m}\right) = 27,700\ ly$

27,700 years = 27.7 million = 8.76×10^{11} seconds

6. If the distance from the Sun to the center of the Milky Way is 2/3 of the radius of the Milky Way, how many light years across is the Milky Way's diameter?

$(27,700\ ly)\left(\frac{3}{2}\right)(2) = 55,100\ ly$

7. The other large galaxy in our local group of galaxies is the Andromeda galaxy. It is 2.9×10^6 light years away. The closest big cluster of galaxies is the Virgo cluster, which is about 4.25×10^7 light years away. The farthest known galaxy is 13 billion light years away. Fill out the table below to imagine the scale of these things in a model where the Milky Way is the size of a dinner plate. Say a dinner plate is 25 cm across.

	Dist. in light years	Dist. in units of Milky Way Galaxy Diameters	Dist in model where the Milky Way is the size of a dinner plate
Dist. to Andromeda	2.9×10^6 ly	55	3.75 meters
Dist. to Virgo	4.25×10^7 ly	510	130 meters
Dist. to farthest galaxy	13×10^9 ly	1.6×10^5	40 km