Problem 3 IOAA Observer on an extrasolar planet

The Sirius star, located in the constellation of Canis Major, is the brightest star in the night sky of the Earth. What the observer's eye sees as a single star is actually a binary star system.

The high brightness of Sirius is a consequence of two facts: its intrinsic luminosity and its proximity to the Earth.

The Mizar multiple star system, in the constellation of Ursa Major, consists of 4 stars seen along the same line of sight from the Earth. Some of these stars form a gravitationally bound system.

Let's assume that an observer (observer A) is located on one of the planets of the Sirius system.

Determine:

a) The magnitude of the Sun as seen by observer A ($m_{\text{Sun,Planet}}$).

b) The magnitude of Sirius star system as seen by the observer A. ($m_{SY,\text{Planet}}$)

c) The combined intrinsic luminosity of the Mizar system, L_{Mizar};

d) the average distance between gravitationally bound stars of the Mizar system and Earth, `

e) The geocentric angular distance between Mizar system and Sirius, $\Delta\theta$;

f) The physical distance between the gravitationally bound stars of the Mizar system and the observer A. ($d_{\text{Mizar,Planet}}$)

g) The magnitude of the entire Mizar system as seen by the observer A. ($m_{\text{Mizar,Planet}}$)

Also estimate amount of errors in all your answers.

The following data may be used:

$d_{\text{Sirius},Earth} = 2.6$ pc- the Sirius – Earth distance;

$m_{\text{Sirius},Earth} = -1.46^{\text{m}}$ - the apparent magnitude of Sirius measured from the Earth;

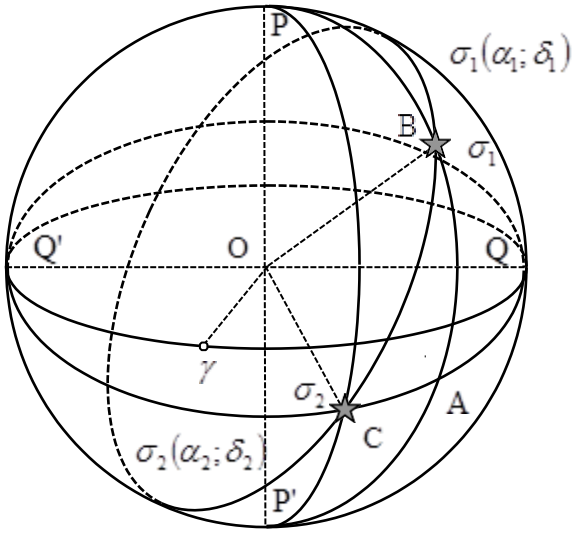
$d_{Sun,Earth} = 1$AU- the Sun – Earth distance;

$m_{Sun,Earth} = -26{,}78^{\text{m}}$ - the apparent magnitude of the Sun as seen from Earth ;

$d_{\text{Sirius,Planet}} = 10$ AU- distance between Sirius and its planet where the observer A is located;

In the table below information for the stars from the Mizar system as measured from the Earth is given.

Star number	Name of the star	Apparent magnitude	Parallax (mili arc seconds)
1	Alcor	3.99 ± 0.01	39.91± 0.13
2	Mizar A	2.23 ± 0.01	38.01± 1.71
3	Mizar B	3.86 ± 0.01	38.01± 1.71
4	Sidus Ludoviciana	7.56 ±0.01	8±4



The equatorial coordinates of Mizar system (σ_1) and respectively of Sirius (σ_2) , located on the heliocentric map are :

$$\alpha_{Mizar} = \alpha_1 = 13^h 23^{min} 55.5^s ; \delta_{Mizar} = \delta_1 = 54^\circ 55' 31'' ; \alpha_{Sirius} = \alpha_2 = 6^h 45^{min} ; \delta_{Sirius} = \delta_2 = -16^\circ 43'.$$

Note
$\ln(1 - x) \approx -x$ for x << 1

$e^x \approx 1 + x$ for x << 1