19. ***REASONING*** The distance between Polaris and earth is equal to the speed of the light multiplied by the time it takes for the light to make the journey. The time is given. Since light is an electromagnetic wave, and all electromagnetic waves travel through a vacuum at the speed of light c, the speed of the light is also known.

SOLUTION The distance s between Polaris and earth is $s = ct$, where t is the time for the light to travel this distance. Using the fact that $1\,\text{yr} = 3.156 \times 10^7\ \text{s}$ (see the table of conversion factors at the front of the book), we find that

$$s = ct = \left(3.00 \times 10^8\ \text{m/s}\right)\left(680\ \cancel{\text{yr}}\right)\left(\frac{3.156 \times 10^7\ \text{s}}{1\ \cancel{\text{yr}}}\right) = \boxed{6.4 \times 10^{18}\ \text{m}}$$