

Question 3

part a, 7%

part b, 5%

An eclipsing binary contains two identical stars, both of mass $1M_{\odot}$. The orbital period of the binary is 10 years and the orbits are elliptical.

(a) (i) What is the average separation of the two stars in AU? Include with your answer a sketch of the orbit of one star with respect to the other showing which quantity it is that you have obtained. Include the centre of mass of the binary star on your sketch.

(ii) Make a sketch of how the intensity of light received from the binary varies over a 20 year period.

(b) If the stars become much larger (e.g. red giants) but the orbit stays the same size, (i) discuss whether the orbital period changes, and (ii) sketch another 20-year light curve, and state how it has changed from the case in part (a)(ii).

$$M+M = \frac{4\pi^2 r_1^3}{G T_1^2} \quad M_{\odot} = \frac{4\pi^2 r_2^3}{G T_2^2}$$

$$2 = \left(\frac{r_1^3}{r_2^3} \right) \left(\frac{T_2^2}{T_1^2} \right) = \left(\frac{r_1^3}{1} \right) \left(\frac{1}{10} \right)^2 = \frac{r_1^3}{100}$$

$$r_1 = \sqrt[3]{200} \approx 6 \text{ AU}$$

