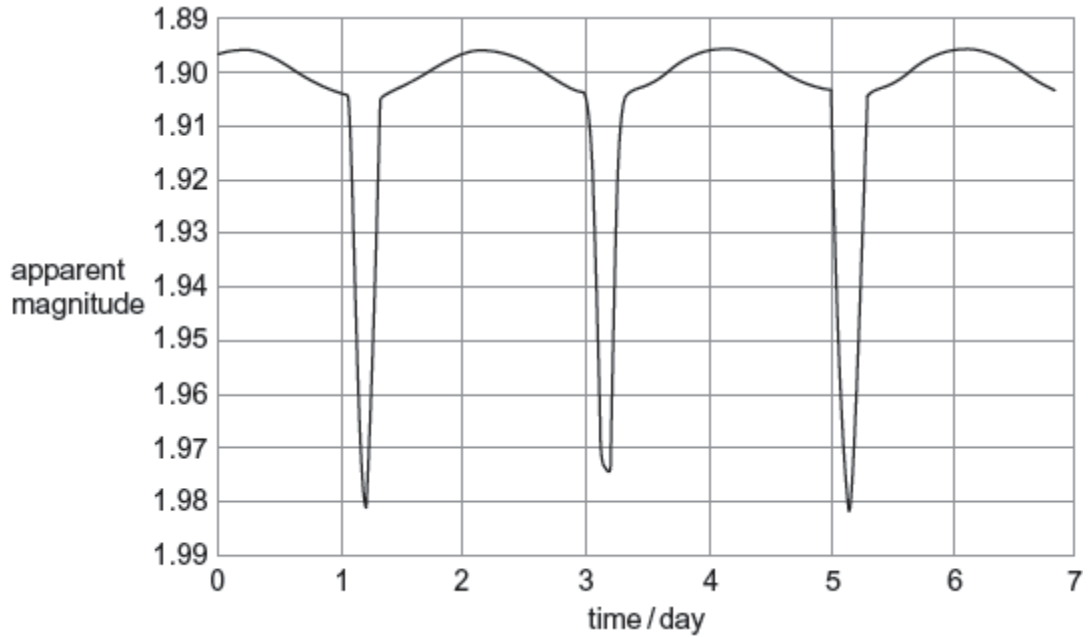**Q1.** Menkalinan is an eclipsing binary star system in the constellation of Auriga. **Figure 1** shows the variation in apparent magnitude with time (light curve) for Menkalinan.

**Figure 1**



Analysis of the spectrum of one of the stars shows a periodic variation in wavelength. **Figure 2** shows the results for one of the spectral lines in the Hydrogen Balmer series. The wavelength for this line as measured for a source in a laboratory on the Earth is 656.28 nm.

**Figure 2**
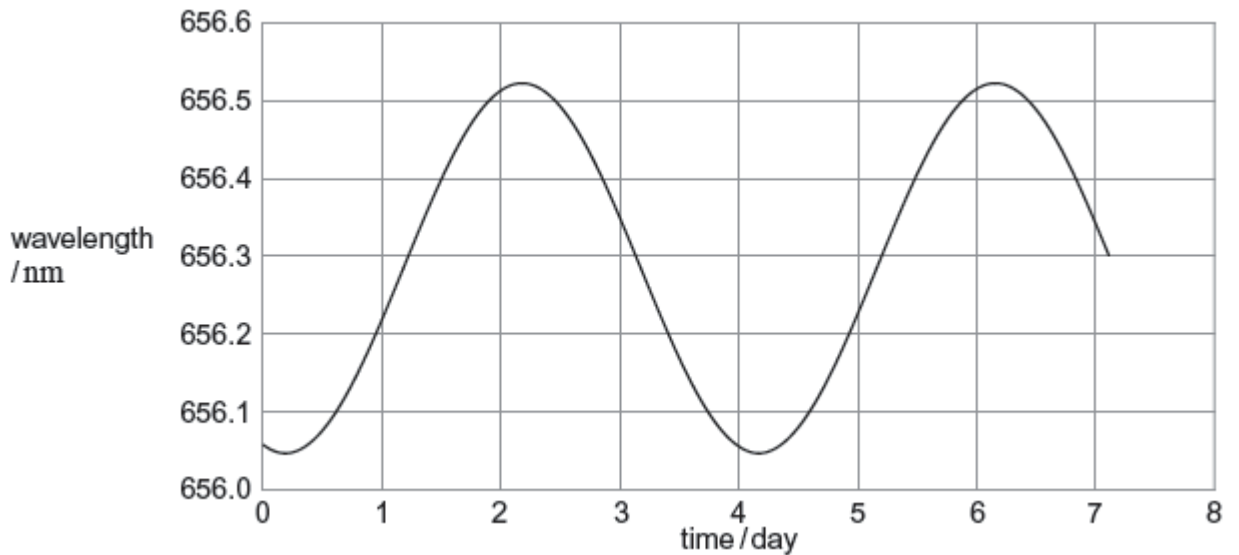


(a)    Describe the physical processes that give rise to the shape of each graph. Go on to show how the information in the graphs can be used to determine properties, such as the speed and period, of the Menkalinan binary system. You should include appropriate calculations in your answer.

The quality of your written communication will be assessed in your answer.

**(6)**

(b)    The black body temperature of each star is approximately 9200 K.

Explain why a Hydrogen Balmer line was chosen for the analysis of wavelength variation.

.......................................................................................................................

.......................................................................................................................

.......................................................................................................................

.......................................................................................................................

.......................................................................................................................

**(2)**

(c)    The distance from the Earth to Menkalinan is $7.7 \times 10^{17}$ m.

Calculate the value of the absolute magnitude of Menkalinan when it appears dimmest.

absolute magnitude = .....................................................

**(3)**
**(Total 11 marks)**

**Q2.** The Summer Triangle consists of three stars, Altair, Deneb and Vega.
Some of the properties of the three stars are summarised in the table below.

|  | **Altair** | **Deneb** | **Vega** |
|---|---|---|---|
|  |  |  |  |

| surface temperature / K | 7700 | 8500 | 9600 |
|---|---|---|---|
| apparent magnitude | 0.77 | 1.25 | 0.03 |
| absolute magnitude | 2.21 | −8.38 | 0.60 |

(a) The three stars belong to the same spectral class.

State and explain which spectral class they belong to.

...........................................................................................................................

...........................................................................................................................

...........................................................................................................................

**(2)**

(b) Deduce which of the three stars appears brightest.

...........................................................................................................................

...........................................................................................................................

...........................................................................................................................

**(2)**

(c) Calculate the distance from Earth to the closest of the three stars.

distance = _____ pc

**(3)**

(d) Deduce which of the three stars is the largest.

...........................................................................................................................

...........................................................................................................................

...........................................................................................................................

.......................................................................................................

.......................................................................................................

.......................................................................................................

.......................................................................................................

.......................................................................................................

.......................................................................................................

**(3)**

(e)    Calculate the wavelength of the peak in the black body radiation curve of Altair.

wavelength = _____ m

**(2)**
**(Total 12 marks)**