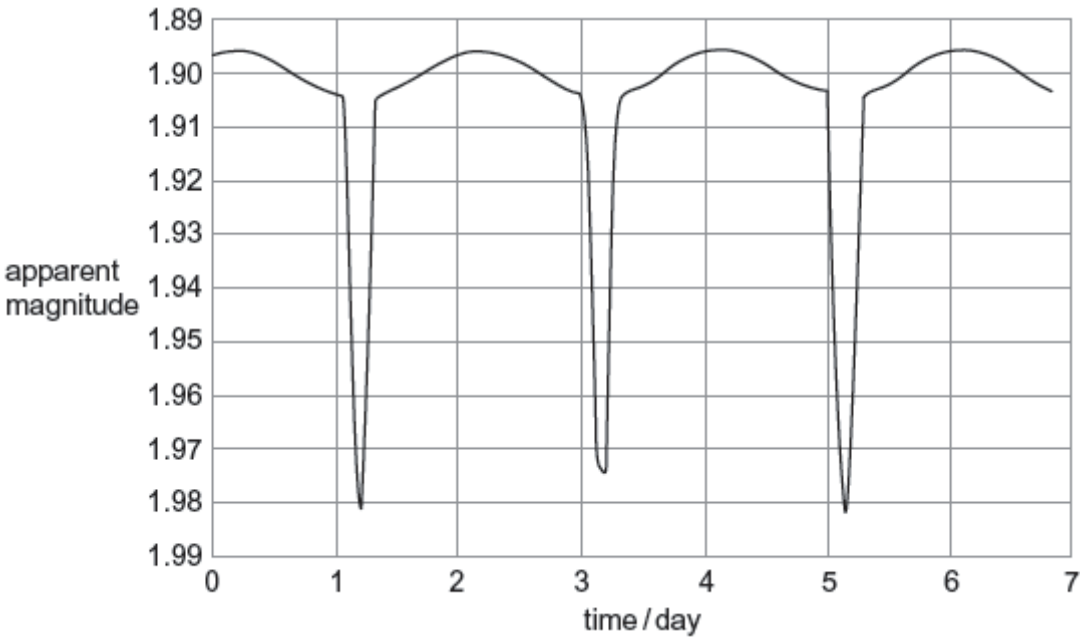
Name of the Student:_____
Max. Marks : 17 Marks **Time : 17 Minutes**

Q1.

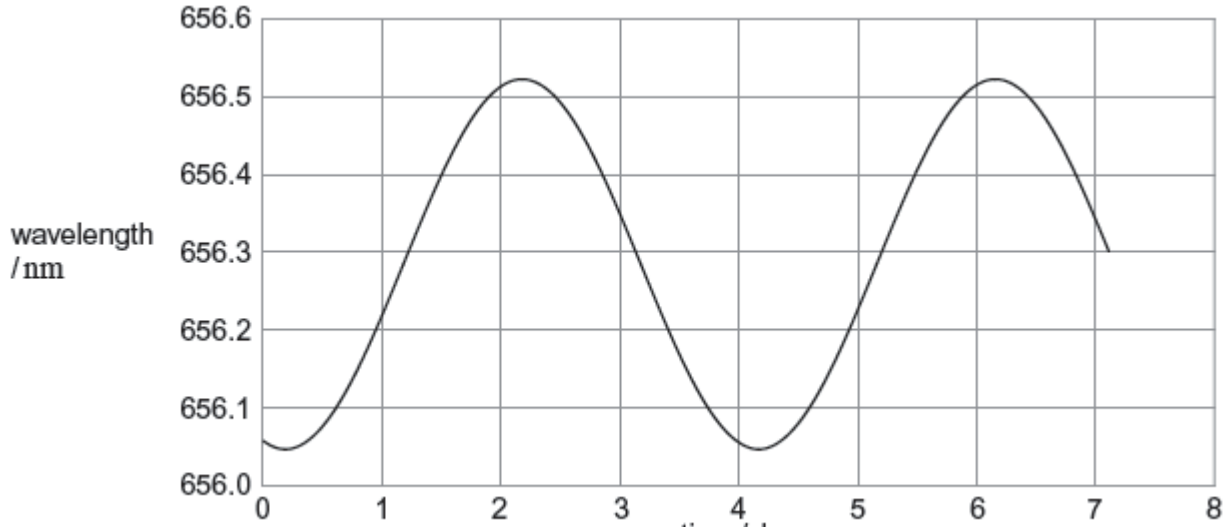
Menkalinan is an eclipsing binary star system in the constellation of Auriga. **Figure 1** shows the variation in apparent magnitude with time (light curve) for Menkalinan.

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 7.7×10^{17} m.

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

absolute magnitude = _____

(3)

(Total 11 marks)

Q2.

NGC 3842 is a galaxy which contains one of the biggest black holes ever discovered.

(a) State what is meant by a black hole.

_____

_____

_____

(1)

(b) The mass of the black hole in NGC 3842 is believed to be 1.0×10^{10} times greater than that of the Sun.

Calculate the radius of its event horizon.

radius = _____ m

(2)

(c) NGC 3842 is 3.3×10^{8} light years from the Earth, and is receding at a velocity of 6.3×10^{6} m s^{-1}.

Estimate, using these data, an age in seconds for the Universe.

age of Universe = _____ s

(3)

(Total 6 marks)