Name of the Student:_____
Max. Marks : 21 Marks **Time : 21 Minutes**

Q1.

(a) The table summarises some of the properties of Vesta, one of the largest objects in the asteroid belt between Mars and Jupiter.

Diameter / m	**Distance from the Sun / AU**	
	smallest	largest
5.4×10^5	2.15	2.57

(i) Calculate the largest possible distance, in m, between the Earth and Vesta.

distance = _____ m

(2)

(ii) Show that when Vesta is at a distance of 1.73×10^{11}d m from Earth, the angle subtended by Vesta to an observer on Earth is about 3×10^{-6} radian.

(2)

(b) Observations of Vesta have been made by the Infrared Telescope Facility (IRTF) in Hawaii.

(i) Draw a ray diagram for a Cassegrain telescope.

(2)

(ii) The IRTF includes a camera capable of detecting infrared radiation with wavelengths in the range 1.0 μm to 5.0 μm.

The smallest angle the telescope can resolve is 3.3×10^{-7} radian.

Calculate the diameter of the objective of the telescope.
Give your answer to a suitable number of significant figures.

diameter of objective = _____ m

(2)

(c) Discuss the level of detail the IRTF would be able to detect on the surface of Vesta, when Vesta is 1.73×10^{11} m from Earth.

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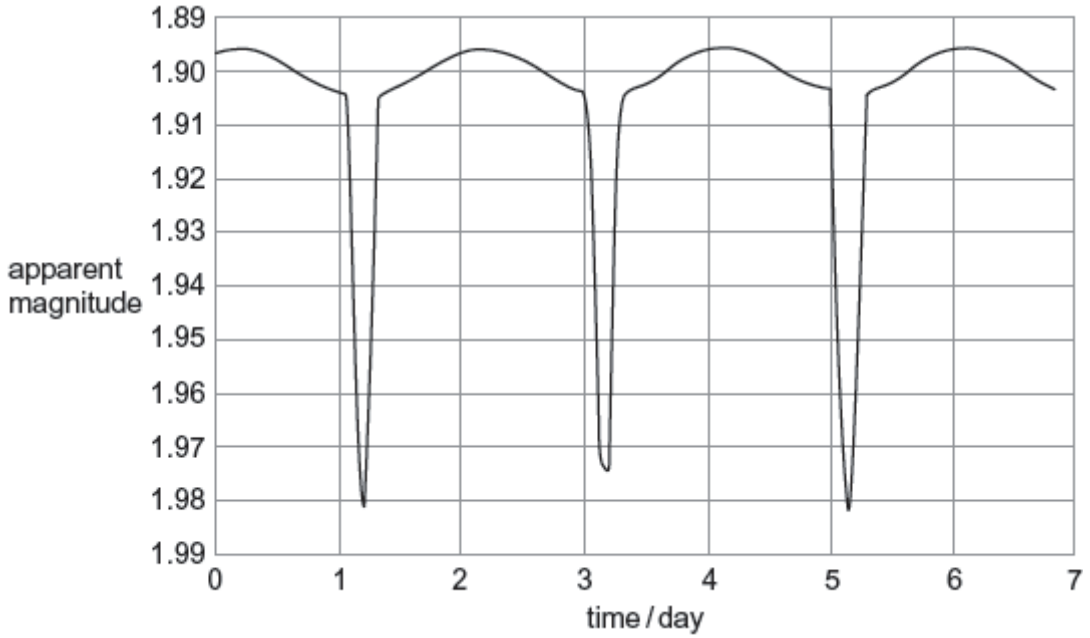
(2)

(Total 10 marks)

Q2.

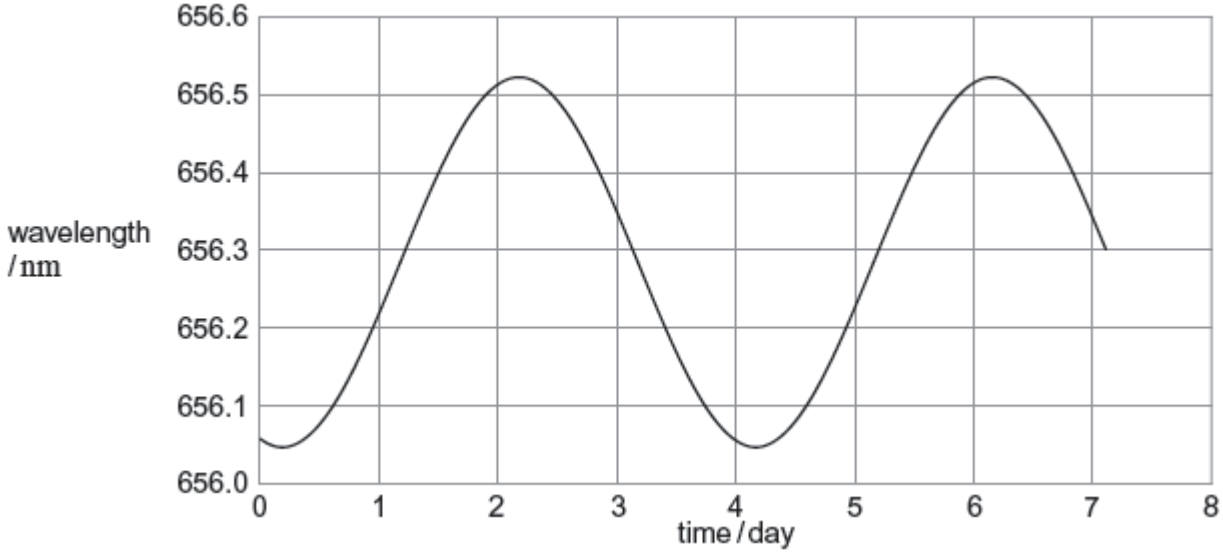
Menkalinan is an eclipsing binary star system in the constellation of Auriga. **Figure 1** shows the variation in apparent magnitude with time (light curve) for Menkalinan.

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.

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(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.

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(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)