

Name of the Student: _____

Max. Marks : 21 Marks

Time : 21 Minutes

Mark Schemes

Q1.

- (a) (i) largest distance =
- $2.57 + 1 = 3.57$
- AU ✓

$$3.57 \text{ AU} = 3.57 \times 1.5 \times 10^{11} \text{ m}$$

$$= 5.36 \times 10^{11} \text{ (m)} \quad \checkmark$$

The first mark is for the correct distance in AU.

The second mark is for the correct conversion to metres. Allow c.e.

2

- (ii) angle =
- s / r

$$= 5.4 \times 10^5 / 1.73 \times 10^{11} \quad \checkmark$$

$$= 3.12 \times 10^{-6} \text{ (rad)} \quad \checkmark$$

Working needs to be shown for the first mark.

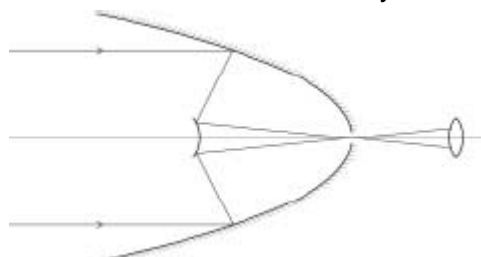
At least two sf needed for final mark.

2

- (b) (i) mirrors correct ✓

primary concave, secondary convex. No shading needed
 primary mirror should be continuous i.e. not two mirrors
 if no hole, evidence can be given by rays passing through
 rays correct ✓

rays must cross after the secondary mirror



The lens does not need to be included.

2

- (ii) angular resolution =
- λ / D
- $D = 1 \times 10^{-6} / 3.3 \times 10^{-7} \quad \checkmark$

$$D = 3.0 \text{ m} \quad 2 \text{ sf needed} \quad \checkmark$$

Allow use of factor of 1.22.

Allow 1 sf if justified by discussion of approximate nature of calculation.

2

- (c) minimum angular resolution is better / smaller than the size of the asteroid ✓
The first mark is for qualitative comparison.

details of about 1/10 the angular size of Vesta / 50km can be seen ✓
the second for the quantitative analysis.

2

[10]

Q2.

- (a) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. The candidate's writing should be legible and the spelling, punctuation and grammar should be sufficiently accurate for the meaning to be clear. The candidates answer should be assessed holistically. The answer will be assigned to one of 3 levels according to the following criteria:

0 marks

Level 1 (1-2 marks)

Lower level (Poor to limited): 1 or 2 marks

The information conveyed by the answer is poorly organised and may not be relevant or coherent. There is little correct use of specialist vocabulary. The form and style of writing may be only partly appropriate.

Calculations:

No relevant calculations. At 1 mark the time period may be quoted as 2 days rather than four.

Discussion

Only one graph discussed (or both very poorly).

At 1 mark there may some attempt to discuss eclipsing or going towards / away.

At 2 marks one discussion will be more correct.

Level 2 (3-4 marks)

Intermediate level (Modest to adequate): 3 or 4 marks

The information conveyed by the answer may be less well organised and not fully coherent. There is less use of specialist vocabulary, or specialist vocabulary may be used incorrectly. The form and style of writing is less appropriate.

Calculations:

Some attempt to use Doppler equation. At four marks there may be only a couple of minor errors.

Discussion:

Correctly links at least one graph to the movement of the two stars in terms of eclipsing or movement relative to each other and the Earth.

Level 3 (5-6) marks

High level (good to excellent): 5 or 6 marks.

The information conveyed by the answer is clearly organised, logical and coherent using appropriate specialist vocabulary correctly. The form and style of writing is appropriate to answer the question.

Calculations:

Doppler equation applied correctly (perhaps a minor error at 5 marks).

At the highest level, the use of 4 days and velocity to give the radius may be seen.

Discussion:

2 graphs discussed. Mostly correct. At 5 marks there may be some minor incorrect statements – e.g. referring to red shift rather than Doppler shift.

Examples of the points made in the response

The explanations expected in a good answer should include most of the following physics ideas:

The time period, T , is the time from the first dip in the light curve to the third dip. (1)

This is approximately 4 days. (L)

This is one full cycle for the wavelength graph. (I)

One full cycle is approximately 4 days. (I)

When one star passes in front of the other the amount of light received changes. (L)

The brightest (lowest value of) apparent magnitude occurs when both stars can be seen. (I)

The dips occur when one star is in front of the other. (I)

The similarity in the dips suggests that both stars have similar temperatures / sizes. (H)

The variation in wavelength is due to the Doppler effect. (I)

The peaks and troughs occur when the stars are moving at their greatest velocity away from / towards us. (H)

The biggest change in wavelength is $656.52 \text{ nm} - 656.28 \text{ nm} = 0.24 \text{ nm}$. (I)

The orbital speed, v , is therefore $\Delta\lambda \times c / \lambda$ (I)

$$= 0.24 \times 3 \times 10^8 / 656.28 = 1.1 \times 10^5 \text{ ms}^{-1}. \text{ (H)}$$

The orbital radius is therefore $v / (2\pi / T) = 6.1 \times 10^9 \text{ m}$. (H)

The letter next to each statement suggests the minimum level of answer the statement may be seen in.

6

- (b) The temperature (9200K) indicates that the star is in spectral class A. ✓

Hydrogen Balmer lines are strongest in A class stars and therefore would be more easily measured. ✓

Reference to class A not essential if it is clear that stars contain hydrogen in $n = 2$ state.

2

- (c) $m - M = 5 \log (d / 10)$
 d (in parsec) = $7.7 \times 10^{17} / 3.08 \times 10^{16} = 25 \text{ pc}$ ✓
dimmiest $m = 1.981$ ✓
dimmiest $M = 1.981 - 5 \log (25 / 10)$
 $= -0.009$ ✓

Allow range 1.980 to 1.982 for m .

Allow c.e. for either d or m .

If both incorrect, no marks are awarded.

3

[11]