

For each Cepheid, the following data are given:

Column 1: The name of the star (note that star 'C8' has been removed from this data set)

Column 2: The period P (in days)

Column 3: The average apparent V-band magnitude of the star

In this question you will use these data to obtain an estimate of the distance of M81.

The period–luminosity relation which you should use in your calculations is:

$$M_V = -2.76 \log(P/\text{days}) - 1.46$$

Where M_V is the absolute magnitude of the Cepheid (averaged over an entire period).

(Note that this is a different relationship to that given in *Activity Booklet 1*.)

- (a) Load the data as described above and create a new column in your spreadsheet which calculates the quantity $\log(P/\text{days})$.

(Note that if you are using Star Office or Microsoft Excel, it is advisable to calculate the logarithm using the function LOG10(), i.e. use LOG10(A1) to calculate the logarithm of the value in cell A1.)

(3 marks)

- (b) In an appropriate column of the spreadsheet, calculate M_V for all of the stars.

(3 marks)

- (c) (i) Write down an equation which relates absolute and apparent magnitudes to the distance d of a star. (If necessary) rearrange this equation such that the distance d is the subject (i.e. you should write an equation of the form $d = \dots$).

(ii) In an appropriate column in your spreadsheet, calculate the distance d to each star. You should display the results of the calculation in scientific notation to three significant figures.

(6 marks)

- (d) You should now have a set of distances to the galaxy M81. In completing this part of the question, it is up to you to decide whether to use the spreadsheet to perform the required calculations. If you do use your spreadsheet to carry out the calculations, make sure that they appear on the completed spreadsheet that you submit for this question (see below), and that any calculated quantities are clearly labelled.

(i) Calculate the mean distance to M81.

- (ii) Estimate the uncertainty associated with the distance calculated in part (c)(i). (For this estimate it is sufficient to adopt the 'rough and ready' approach which is described in Section 3.1 of the Observational activities part of *Activity Booklet 1* (p. 147). However, you may alternatively choose to calculate the uncertainty using functions available in the spreadsheet – full marks will be awarded where this is done correctly.)
- (iii) Quote your final result (with uncertainty) in suitable units and to an appropriate number of significant figures.

(6 marks)

- (e) (i) In this analysis, no account has been made for absorption by interstellar dust. Make a qualitative statement about how your result would change if you could make proper allowance for interstellar absorption (i.e. would the measured distance decrease or increase?). Explain your answer.
- (ii) The measurement of the distance of M81 is important for calibrating several other methods of distance determination. Identify one technique for which the distance to M81 would be a useful calibration value. Briefly explain why your chosen technique is applicable to M81.

(4 marks)