

General Rules

These are general guidelines for the grading of all problems. All of the rules listed below refer to deductions on specific items in the marking scheme.

Using less than 70% of the total area for the graph	Deduct 20% of the marks for correct graph
Non-constant scale for axis	Deduct 20% of the marks for correct graph
Missing or incorrect labels or units in the axes	Deduct 20% of the marks for correct graph

D1. Photometric comparison of surveys (75 points)**(a) 5 points**

- **5 points:** Realize that the data from the left table is from DES, whereas the one from the right table is from SDSS.

(b) 35 points

- **12.5 points:** Correct graph for SDSS data using semi-log paper. $\frac{12.5}{14}$ points will be awarded for each correctly placed point.
- **12.5 points:** Correct graph for DES data using semi-log paper. $\frac{12.5}{12}$ points will be awarded for each correctly placed point.
- **5 points:** Correct parameters A and B for SDSS data. 2.5 points will be awarded for each correct parameter within a 10% range of the correct fit.
- **5 points:** Correct parameters A and B for DES data. 2.5 points will be awarded for each correct parameter within a 10% range of the correct fit.
Note: If the student uses a graphical method to obtain parameters A and B but does not draw support lines, then no marks are given. As graphical methods can depart from analytical.

(c) 5 points

- **2.5 points** Obtain correct values for the Signal to Noise ratio (S/N) within a 10% range for SDSS.
- **2.5 points** Obtain correct values for the Signal to Noise ratio (S/N) within a 10% range for DES.

(d) 15 points

- **15 points** Match correctly the IDs of the data sets. $\frac{15}{7}$ points for each match.

(e) 15 points

- **12 points** Correct graph using millimeter paper. $\frac{12}{7}$ points will be awarded for each correctly placed point and double error bars.
- **3 points** Correct identification of the stars that would be suitable for photometric calibration between the two surveys using ID's of Table 1 (DES).

D2. Shapley Hypothesis (75 points)
(a) 20 points

- **2.5 points:** Calculate the distance to each GC using distance modulus. Deduct $-\frac{2.5}{25}$ points for each wrong value
- **2.5 points:** Equate change of coordinates from polar to Cartesian coordinates
- **15 points:** Calculate x , y and z components of each GC. **5 points** for each component. Deduct $-\frac{5}{25}$ points for each wrong value

(b) 20 points

- **3 points:** Calculate \bar{x} , \bar{y} and \bar{z} . **1 point** for each value.
- **6 points:** Calculate $\sigma_{\bar{x}}$, $\sigma_{\bar{y}}$ and $\sigma_{\bar{z}}$. **2 points** for each value.
- **2 points:** Write formula of D
- **3 points:** Reasonable method for σ_D estimation
- **2.5 point:** Calculate numerical value of D
- **3.5 points:** Calculate numerical value of σ_D . If the numerical value appears reasonable but the student did not explain their method, deduct **-1.5 points**.

(c) 30 points

- **24 points:** Correct histogram for x , y and z . **8 points** for each plot. **Deduct 50% of the points for this criterion** if the student uses the wrong method for constructing the histograms. Reminder: bin's size and first bin position.
- **3 points:** Calculate Q_{1x} , Q_{2x} , Q_{3x} , Q_{1y} , Q_{2y} , Q_{3y} , Q_{1z} , Q_{2z} and Q_{3z}
- **3 points:** Represent Q_{1x} , Q_{2x} , Q_{3x} , Q_{1y} , Q_{2y} , Q_{3y} , Q_{1z} , Q_{2z} and Q_{3z} on their respective histograms (**1 point** for each histogram).

(d) 5 points

- **3 points:** Calculate ϕ_x , ϕ_y and ϕ_z and evaluate their symmetry types (**1 point** for each value).
- **2 points:** Correctly concluding that it is FALSE.