## PHY306 QUESTIONS FOR SHAPLEY 1918A

**Answer all questions. Some questions may require you to consult other sources: if so, remember to reference the sources used in standard style (see the Department's web page on "Plagiarism and Collusion" for instructions on referencing). Always use your own words, unless there is justification for a brief direct quote—if there is, use quotation marks. This exercise counts 5% towards your total module mark.**

1. *Briefly* (unlike Shapley!) explain the methods used by Shapley to determine distances to globular clusters. Comment on whether these methods are still used in modern distance determination. [4]

2. Shapley talks about the "parallactic motions" of Galactic Cepheids. Since he also says that they have "parallaxes rarely exceeding a few thousandths of a second of arc", he clearly doesn't mean that he has observed the trigonometric parallaxes of these stars (the technology of 1918 was definitely not capable of measuring milliarcsecond parallaxes!). So what does he mean, and what are the problems with this method of distance determination? [3]

3. Shapley's distances are generally too large—for example, he considers the Sun to be 20 kpc from the Galactic centre, whereas modern estimates are of order 8−8.5 kpc. Discuss likely reasons for this. [3]

4. Shapley finds (see his figure 2) that the globular clusters avoid the region close to the Galactic plane. He further observes that this is also true of the spiral nebulae, and uses this similarity and the fact that globular clusters, like spiral nebulae, have high Doppler velocities to argue that spiral nebulae, like globular clusters, are part of the Milky Way and not external systems. With hindsight, this reasoning is erroneous. Explain what is wrong with Shapley's logic. [3]

5. Shapley's figure 3 shows a large peak in the distribution of B-class stars in the globular cluster M3. What is this peak? Shapley says that the absolute magnitude of the peak is −0.2: what does that imply for the distance of M3? What is the modern distance estimate? [2]