

GA 1

1. Briefly describe the classification of galaxies in the *Hubble sequence* (tuning fork), paying attention to such aspects as *colour*, overall shape, and notable features of the galaxies. [4 marks]

Answer:

Galaxies are arranged along a tuning-fork, with elliptical galaxies along the handle of the fork, and spirals along the prongs [1 mark]

Isophotes (lines of constant surface brightness) in elliptical galaxies are elliptical in shape, and such galaxies are red (in optical colours). In contrast, spirals are disk-like and are blue. [2 marks]

Spirals are further divided in barred versus non-barred, and according to how tightly wound their spiral arms are, or the ratio of bulge to disk light [1 mark]

Students could also answer this question with a sketch, provided it addresses shape, colour, and pitch angle or disk/bulge ratio of spirals.

2. What are *Cepheid variables*. How are they used to determine distances to galaxies? [4 marks]

Answer:

Cepheids are variable stars (luminosity varies in time), of which the luminosity L is related to the period P of the variation: they follow a period-luminosity relation. [2 marks]

Measuring P yields L from the $P - L$ relation. Observations can be used to measure F , the flux of the star. Combining F and L yields the distance d using $F = L/(4\pi d^2)$. [2 marks]

Note: this assumes that absorption can be neglected, which is not always a good approximation. In the presence of absorption, the relation $F = L/(4\pi d^2)$ no longer holds.

3. One parsec (1 pc) is the distance at which one astronomical unit (by definition 1 AU=149597870700 m) subtends an angle of one arc second. Calculate the length of a parsec in meters, and in light years.[2 marks]

Answer:

An angle of 1 arc seconds is $\theta = 2\pi/(3600. \times 360) \sim 4.85 \times 10^{-6}$ radians. This angle is small, so we can safely use the 'small angle' approximation, $\sin(\theta) \approx \tan(\theta) \approx \theta$ (for θ in radians). Making the small angle approximation, $\theta = \text{AU}/\text{pc}$, from which 1 pc=3.08568 $\times 10^{16}$ m [1 mark]

One light year = c yr, long, hence 1 pc \approx 3.26 lj. [1 mark]