

## Year 1 Introduction to Astrophysics

### Practice problems 1

- With the aid of a diagram, show that the angle of elevation of the Pole Star from the horizon for an observer in the northern hemisphere on the Earth is equal to the latitude of the observer.
  - From Birmingham (latitude  $52^\circ\text{N}$ , longitude  $1^\circ\text{W}$ ), what will be the maximum and minimum altitude (above the horizon) of the star Vega (declination  $39^\circ$ )? Explain your answer with a diagram.  
(Hint: you may find it easier to calculate the angle from the zenith first.)
- What time of year would you choose to observe the galaxy M33 (RA=1h33m51s, Dec=+30d39m36s) with an optical telescope? Would you use a Northern or Southern hemisphere observatory? At what Local Sidereal Time would it be highest in the sky?
- If a spherical star cluster of diameter 10 pc lies at a distance of 2 kpc from Earth
  - What is its diameter in arcseconds?
  - What is its parallax?
  - What area on the sky, in steradians, does it cover?
- The bright star Rigel has a surface temperature of 11,000 K, and a radius 70 times that of our Sun. Estimate its luminosity in Watts, and in solar luminosities.
- A Cepheid in an external galaxy is estimated to have a luminosity 10,000 times that of our sun, and its apparent visual band magnitude is  $m_V=24.83$ . Given that the Sun has absolute magnitude  $M_V=4.83$ , estimate the distance of the galaxy in which this variable star resides.
- The Sun has a colour index  $B-V=0.66$ , whilst the blue star Rigel has  $B-V=-0.03$ . If a nearby sun-like star were similar in brightness to Rigel in the B band, how would its flux compare to that of Rigel in the V band? (Be quantitative.)
- A galaxy is observed to be receding from the sun at a velocity of  $75,000 \text{ km s}^{-1}$ . The distance to the galaxy is measured independently and is found to be  $1.2 \times 10^9 \text{ pc}$ . On the basis of this galaxy, calculate the values of:
  - The Hubble constant (in  $\text{km s}^{-1} \text{ Mpc}^{-1}$ ).
  - The Hubble time, in years.
  - The approximate size of the observable Universe (in Mpc).State any assumptions you make.

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