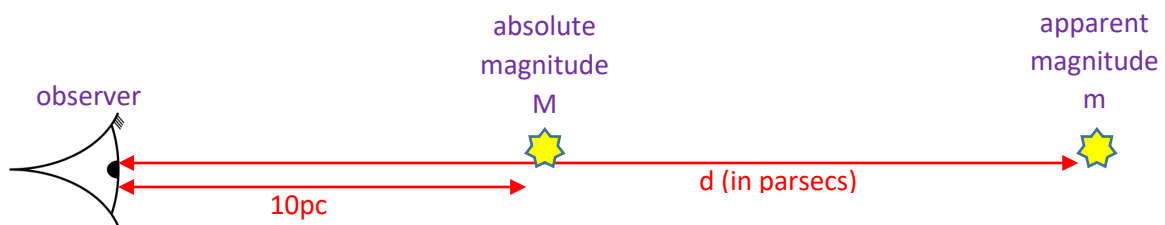### 9.2.3 Absolute magnitude

We have already seen, in section 9.2.1, that magnitude is a measure of the brightness of stars as they appear to the human eye. Magnitude is a logarithmic scale. The brightness of stars is dependent on how bright they actually are (intrinsic brightness), but also on how far away they are. For example, a more distant bright star can appear to the same brightness as a dimmer star which is closer to us. The brightness of stars, as they appear to us on Earth is called the <u>apparent magnitude</u>. <u>Absolute magnitude</u> is a way of comparing the actual, intrinsic brightness of stars. The way that absolute magnitude is determined is to consider moving stars to the same distance away from us and calculating their magnitude if they were at that distance. The distance chosen is 10 parsecs.

The relationship between apparent magnitude (m), absolute magnitude (M), and distance is given by the relationship:

$$m - M = 5 \log_{10}\left(\frac{d}{10}\right)$$

where d=distance to star in parsecs

Worked example:

The star Pollux (in Gemini) has an apparent magnitude of 1.14. It is at a distance of 12.3pc. What is its absolute magnitude?

$$m - M = 5 \log_{10}\left(\frac{d}{10}\right)$$

$$\therefore 1.14 - M = 5 \log_{10}\left(\frac{12.3}{10}\right)$$

$$\therefore 1.14 - M = 5 \log_{10}\left(\frac{12.3}{10}\right) = 0.45$$

$$\therefore M = 1.14 - 0.45 = \underline{0.69}$$

(1) ✎ The star Vega (in Lyra) has an absolute magnitude of 0.60. It is at a distance of 7.7pc. What is its apparent magnitude?

(2) ✏ *The star Rigel (in Orion) has an apparent magnitude of 0.12 and an absolute magnitude of -8.1. How far away is it, in parsecs?* *(Hint: Take care with the negative magnitude.)*

(3) ✏ *The star Sirius (in Canis Major) has an apparent magnitude of -1.46. It is at a distance of 8.6ly. What is its absolute magnitude?* *(Hint: You need to covert from light years to parsecs)*

(4) ✏ *The Sun lies at a distance of 150 million kilometres. It has an apparent magnitude of -26.7. What is its absolute magnitude?* *(Hint: You need to covert from kilometres to parsecs)*