# IISER Mohali School of Astronomy

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# 1 INTRODUCTION TO ASTRONOMY

## 1.1 Quiz-I

### 1.1.1 A:

**Given that:**

- Apparent magnitude: $m$
- $m_x = -2.5 \log_{10} \left( \frac{F_x}{F_{x,0}} \right)$
- $F_x$: observed flux density (spectral filter 'x')
- $F_{x,0}$: reference flux 'zero-point' (for photometric filter)

Pogson's Ratio: $\sqrt[5]{100} = 2.512$ So, inverting the formula, we get:

$$\Delta m = \frac{1}{0.4} \log_{10} \left( \frac{F_2}{F_1} \right)$$

Thus, the flux ratio will be:

$$\frac{F_2}{F_1} = 10^{0.4 \times \Delta m}$$

where $\Delta m$ is the difference in magnitudes $m_1 - m_2$.

### 1.1.2 A:

**Given that:**

- Sirius: $m = -1.4$
- Venus: $m = -4.4$

Because smaller/negative numbers correspond to brighter stars, Venus is brighter than Sirius.

**B:**

- Vega: $m = 0.03$
- Antares: $m = 1.06$

Because bigger/positive numbers correspond to dimmer stars, Vega is brighter than Antares.

#### 1.1.3 A:

Given the two stars:

- One with lesser luminosity to the eye and smaller in size.
- Another with higher luminosity and greater size to the eye.

And still, there is a possibility of the smaller star being brighter than the bigger star, because of the distance between the observer and the star.

#### 1.1.4 A:

**Given that:**

- Absolute brightness:
  - $M_{sun} = 4.8$
  - $M_{sirius} = 1.4$
  - $M_{betelgeuse} = -5.6$
- Apparent brightness:
  - $m_{sun} = -26$
  - $m_{sirius} = -1.46$
  - $m_{betelgeuse} = 0.50$

So, from Earth, the brightest will be:

$$Sun >> Sirius > Betelgeuse$$

In absolute sense, the brightest will be:

$$Betelgeuse > Sirius > Sun$$

#### 1.1.5 A:

**Given that:**

- Absolute brightness:
  - $M_{sun} = 4.8$
  - $M_{sirius} = 1.4$

- $M_{betelgeuse} = -5.6$

- Apparent brightness:
  - $m_{sun} = -26$
  - $m_{sirius} = -1.46$
  - $m_{betelgeuse} = 0.50$

Closest will be:

$$Sun >> Sirius > Betelgeuse$$

Farthest will be:

$$Betelgeuse > Sirius > Sun$$

Using Distance Modulus:

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

**For the Sun:**
**Given:**

- Absolute brightness: $M_{sun} = 4.8$
- Apparent brightness: $m_{sun} = -26$

**Calculation:**

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

$$-26 - 4.8 = 5\log_{10}\left(\frac{r}{10}\right)$$

$$-30.8 = 5\log_{10}\left(\frac{r}{10}\right)$$

$$-6.16 = \log_{10}\left(\frac{r}{10}\right)$$

$$10^{-6.16} = \frac{r}{10}$$

$$r = 10^{(-6.16+1)}pc = 10^{-5.16}pc$$

So, the distance to the Sun is approximately $10^{-5.16}$ parsecs.
**For Sirius:**
**Given:**

- Absolute brightness: $M_{sirius} = 1.4$
- Apparent brightness: $m_{sirius} = -1.46$

**Calculation:**

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

$$-1.46 - 1.4 = 5\log_{10}\left(\frac{r}{10}\right)$$

$$-2.86 = 5\log_{10}\left(\frac{r}{10}\right)$$

$$-0.572 = \log_{10}\left(\frac{r}{10}\right)$$

$$10^{-0.572} = \frac{r}{10}$$

$$r = 10^{(-0.572+1)}pc = 10^{0.428}pc$$

So, the distance to Sirius is approximately $10^{0.428}$ parsecs.
**For Betelgeuse:**
**Given:**

- Absolute brightness: $M_{betelgeuse} = -5.6$
- Apparent brightness: $m_{betelgeuse} = 0.50$

**Calculation:**

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

$$0.50 - (-5.6) = 5\log_{10}\left(\frac{r}{10}\right)$$

$$6.10 = 5\log_{10}\left(\frac{r}{10}\right)$$

$$1.22 = \log_{10}\left(\frac{r}{10}\right)$$

$$10^{1.22} = \frac{r}{10}$$

$$r = 10^{(1.22+1)}pc = 10^{2.22}pc$$

So, the distance to Betelgeuse is approximately $10^{2.22}$ parsecs.
Q: **Why is the sky blue?**

**A:** As the white light from the Sun enters Earth's atmosphere, much of the red, yellow, and green wavelengths of light (mixed together and still nearly white) pass straight through the atmosphere to our eyes. The blue and violet waves, however, are just the right size to hit and bounce off of the molecules of gas in the atmosphere. This causes the blue and violet waves to be separated from the rest of the light and become scattered in every direction for all to see. The other wavelengths stick together as a group, and therefore remain white. Closer to the horizon, the sky fades to a lighter blue or white. The sunlight reaching us from the horizon has passed through even more air than the sunlight reaching us from overhead. The molecules of gas have rescattered the blue light in so many directions so many times that less blue light reaches us.

Essentially, blue light is scattered more than other colors because it travels as shorter, smaller waves. This is why we see a blue sky most of the time.

Q: **Why are the sunsets red?**

**A:** As the Sun gets lower in the sky, its light passes through more of the atmosphere to reach you. Even more of the blue and violet light is scattered, allowing the reds and yellows to pass straight through to your eyes without all that competition from the blues. Also, larger particles of dust, pollution, and water vapor in the atmosphere reflect and scatter more of the reds and yellows, sometimes making the whole western sky glow red.

Essentially, due to the longer distance from eye to the sun during sunset, the redder wavelengths are helpful and thus, they are scattered more than the blue light during sunrise and sunset.