1. (U11 - 5.26) (a) Sirius

radius of $1.67\ R_\odot$ $\qquad$ $R_\odot = 6.96 \times 10^8\ m$

luminosity of $25\ L_\odot$ $\qquad$ $L_\odot = 3.90 \times 10^{26}\ W$

radius of Sirius $= 1.67\ R_\odot = 1.16232 \times 10^9\ m = R_s$

luminosity of Sirius $= 25\ L_\odot = 9.75 \times 10^{27}\ W = L_s$

energy flux of Sirius $= F_s = \dfrac{L_s}{4\pi \cdot R_s^2}$

$$= \frac{9.75 \times 10^{27}\ W}{4\pi \cdot (1.16232 \times 10^9\ m)^2}$$

$$= \frac{9.75 \times 10^{27}\ W}{4\pi \cdot (1.351 \times 10^{18}\ m^2)} = \frac{9.75 \times 10^{27}\ W}{1.6977 \times 10^{19}\ m^2}$$

$$= 5.743 \times 10^8\ W m^{-2}$$

1. (b)

$$F = \sigma \cdot T^4$$

$$\sigma = 5.67 \times 10^{-8}\ Wm^{-2}K^{-4}$$

$$F = 5.743 \times 10^{8}\ Wm^{-2} = 5.743 \times 10^{8}\ Jm^{-2}s^{-1}$$

$$5.743 \times 10^{8}\ Wm^{-2} = (5.67 \times 10^{-8}\ Wm^{-2}K^{-4})\,T^4$$

$$T^4 = \frac{5.743 \times 10^{8}\ Wm^{-2}}{5.67 \times 10^{-8}\ Wm^{-2}K^{-4}}$$

$$T^4 = 1.01 \times 10^{16}\ K^4$$

$$T = 1.01 \times 10^{4}\ K = 10{,}100\ K$$

Box 5-2 says temperature is ~10,000 K, so our answers match. ✓

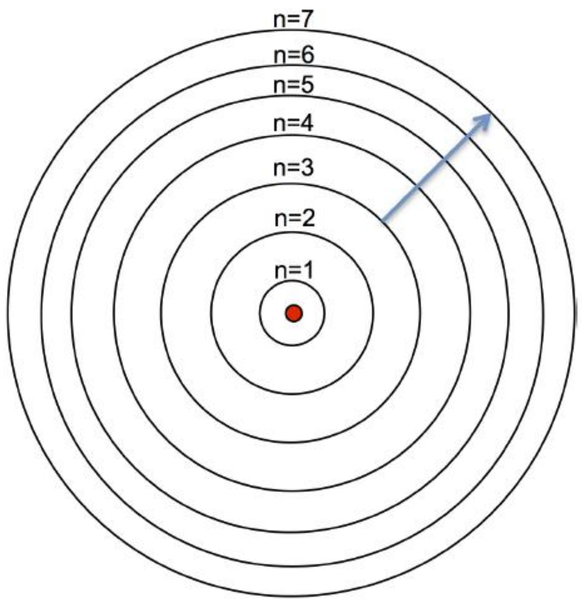
(a) To find the wavelength of P_Δ, i.e. the 4$^{\text{th}}$ wavelength in the Paschen series, use the Bohr formula,

$$\frac{1}{\lambda} = R\left(\frac{1}{N^2} - \frac{1}{n^2}\right) \qquad \text{where } R = 1.097 \times 10^7 \text{ m}^{-1}$$

Paschen series: set $N = 3$
4$^{\text{th}}$ wavelength of Paschen series: set $n = 3 + 4 = 7$

$$\Rightarrow \quad \frac{1}{\lambda} = (1.097 \times 10^7)\left(\frac{1}{3^2} - \frac{1}{7^2}\right)$$
$$\lambda = 1.01 \times 10^{-6} \text{ m} = 1.01\ \mu\text{m}$$

(b) The P_Δ line is the transition between the 3$^{\text{rd}}$ and 7$^{\text{th}}$ energy level.



(c) With the wavelength of 1.01×10^{-6} m $= 1.01\ \mu$m, the line is in the infrared.

For the red light, $\lambda_{\text{rest}} = 700$ nm
To be observed as green light, $\lambda_{\text{obs}} = 500$ nm
Wavelength shift $\Delta\lambda = \lambda_{\text{obs}} - \lambda_{\text{rest}} = (500 - 700)$ nm $= -200$ nm

Using the Doppler shift equation,

$$\frac{v}{c} = \frac{\Delta\lambda}{\lambda_{\text{rest}}}$$

$$\Rightarrow v = \frac{\Delta\lambda}{\lambda_{\text{rest}}} c = \left(\frac{-200 \text{ nm}}{700 \text{ nm}}\right)(3 \times 10^8 \text{ m s}^{-1}) = -8.57 \times 10^7 \text{ m s}^{-1} = -8.57 \times 10^4 \text{ km s}^{-1}$$

This means you are going at a speed of 8.57×10^4 km s^{-1} towards the light if your claim is true. You definitely deserve a ticket.

4. (U11-6.33) (a)

Frequency of 43 GHz $= 43 \times 10^{9}\ Hz = 4.3 \times 10^{10}\ Hz$.

$$\lambda = \frac{c}{f} = \frac{3 \times 10^{8}\ m/s}{4.3 \times 10^{10}\ Hz} = .69767 \times 10^{-2}\ m = .0069767\ m$$

$$\boxed{\approx .007\ m}$$

4. (4II - 6.33) (b)

For angular resolution,

$\theta = 2.5 \cdot 10^5 \cdot \frac{\lambda}{D}$

$D = 25{,}000$ Km
$= 25{,}000{,}000$ m

$\lambda = .007$ m

$\theta = 2.5 \cdot 10^5 \cdot \left(\frac{.007 \text{ m}}{25{,}000{,}000 \text{ m}} \right)$

$= (2.5 \cdot 10^5)(2.8 \times 10^{-10})$

$= (2.5 \times 2.8)(10^5 \times 10^{-10})$

$= 7 \times 10^{-5}$ arcsec

The astronomers are looking for absorption lines.
The distant galaxy emits a continuous spectrum. The light from this distant galaxy then passes through the ionized oxygen gas surrounding the Milky Way, for which the gas absorbs light at particular wavelengths. Absorption line spectrum is therefore expected.