# ASTRO 358 ((UNIQUE 48540) : QUIZ 1, SOLUTION SET

Total score = 50 points.

1. For a high mass ($M > 8\ M_\odot$) star: the outer envelope is ejected as a supernova remnant, and the inert iron core implodes into either a neutron star or a black hole ([**10 pts**]).

2.For a low mass ($M \sim\ 1\ M_\odot$) star: outer envelopes become a planetary nebula, while inert core becomes a white dwarf ([**10 pts**]).

3. According to Wien's law, a blackbody emits the maximum flux in its continuum spectrum at a wavelength $\lambda_{\rm peak}$ that is inversely proportional to its surface temperature $T$:

$$\lambda_{\rm peak} = \frac{W}{T}, \tag{1}$$

where $W$ = Wien's constant = $2.9 \times 10^{-3}$ m K.

Thus, stars that emit a large fraction of their flux at ultraviolet wavelengths ($\lambda \sim 2 \times 10^{-8}$ m) have surface temperatures of $\sim$ 100,000 K. *Such hot stars are very massive and have lifetimes of only a few million years. They are therefore only present in recent sites of star formation.*

[[**10 pts**] = 4 pts for applying Wien's law, 3 pts for stating that hot stars are very massive stars, 3 pts for stating that high mass stars have short lifetimes.]

4. Stefan-Boltzmann law : The total flux $F_{\rm surf}$ emitted at the surface of a star (or blackbody) over all wavelengths is proportional to the fourth power of its surface temperature $T$:

$$F_{\rm surf} = \sigma T^4 \tag{2}$$

where $\sigma$ = Stefan-Boltzmann constant = $5.7 \times 10^{-8}$ J s$^{-1}$ m$^{-2}$ K$^{-4}$

Flux at surface of a star of radius R:

$$F = \frac{L}{4\pi R^2} \tag{3}$$

Hence,

$$L = 4\pi R^2 \sigma T^4 \propto R^2 T^4 \tag{4}$$

Flux that we receive at distance $d$

$$f = \frac{L}{4\pi d^2} \propto \frac{R^2 T^4}{d^2} \tag{5}$$

If the radius and surface temperature of a star both double, the flux that we receive rises by a factor of 4x16 or 64.

[[**10 pts**] = 7 pts for $f \propto (R^2\ T^4/d^2)$ + 3 pts for math.]

5. $B$-$K$ = $m_{\rm B}$ - $m_{\rm K}$ = -2.5 log($f_{\rm B}$/ $f_{\rm K}$) = 3.2 mag.

If the flux of the galaxy at blue wavelengths rises by a factor of 100, the $B$-$K$ color falls by 5 magnitudes to -1.8 mag.

[[**10 pts**]= 6 pts for showing relation of color to flux + 4 pts for math.]