PHYS 20323/60323: Fall 2023 - LaTeX Example

1. The following questions refer to the Table below.

Note: There may be multiple answers.

Name	Mass	Luminosity	Lifetime	Temperature	Radius
η Car.	60 $M_\odot$	10^6 $L_\odot$	8.0 x 10^5 years		
ϵ Eri.	6.0 $M_\odot$	10^6 $L_\odot$		20,000 K	
σ Scu.	2.0 $M_\odot$		5.0 x 10^8 years		2 $R_\odot$
β Cyg.	1.3 $M_\odot$	3.5 $L_\odot$			
α Cen.	1.0 $M_\odot$				1 $R_\odot$
γ Del.	0.7 $M_\odot$		4.5 x 10^10 years	5000 K	

(a) (4 points) Which of these stars will produce a planetary nebula.

(b) (4 points) Elements heavier than Carbon will be produced in which stars

2. An electron is found to be in the spin state (in the z-basis): x=A$\binom{3i}{4}$

(a) (5 points) Determine the possible values of A such that the state is normalized.

(a) (5 points) Find the expectation values of the operators S_x, S_y, S_z and $\overrightarrow{S^2}$.

The matrix representations in the z-basis for the components of electron spin operators are given by:

$S_x=\frac{h}{2}\begin{pmatrix}0 & 1\\ 1 & 0\end{pmatrix}$; $S_y=\frac{h}{2}\begin{pmatrix}0 & -i\\ i & 0\end{pmatrix}$; $S_z=\frac{h}{2}\begin{pmatrix}1 & 0\\ 0 & -1\end{pmatrix}$;

3. The average electrostatic field in the earth's atmosphere in fair weather is approximately given:

$$\vec{E} = E_0(Ae^{-az} + Be^{-bz})\hat{z},$$

where A, B, α, β are positive constants and z is the height above the (locally flat) earth surface.

(a) (5 points) Find the average charge density in the atmosphere as a function of height

(b) (5 points) Find the electric potential as a function height above the earth.