PHYSICS X0323: Fall 2025 - LaTeX Example

1. At time t = 0 a particle is represented by the wave function

$$\Psi(x) = \begin{cases} A\binom{x}{a}, & 0 \le x \le a \\ A\binom{b-x}{b-a}, & a \le x \le b \\ 0, & \text{otherwise} \end{cases} \tag{1}$$

where A, a and b are constants.

(a) (3.3 points) Normalize Ψ (i.e., find A terms of a and b).

(b) (3.3 points) Where is the particle likely to be found at $t = 0$?.

(c) (3.4 points) What is the expectation value of x?.

2. The following questions refer to stars in the Table below.
Note: There may be multiple answers.

Name	Mass	Luminosity	Lifetime	Temperature	Radius	Variable?
δ Scu.	2.0 $M_\odot$		5.0×10^8 years		2.0 $R_\odot$	Y
γ Del.	0.7 $M_\odot$		4.5×10^{10} years	5000 K		N
β Cyg.	1.3 $M_\odot$	3.5 $L_\odot$				Y
η Car.	60. $M_\odot$	10^6 $L_\odot$	8.0×10^5 years			Y
ε Eri.	6.0 $M_\odot$	10^3 $L_\odot$		20,000 K		N
α Cen.	1.0 $M_\odot$			6000 K	1.0 $R_\odot$	N

(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.

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

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

(b) (5 points) Find the expectation values of the operators S_x, S_y, S_z and S^2.

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

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

Latex Example