

Question 3: Quantum Mechanics

1. **Determine** if the following functions are eigenfunctions of the p_x operator. If yes, identify the eigenvalue, if no, explain why not. **Show your working.**

a) x^3

b) e^{ikx}

[5 marks]

2. **Discuss** the function below, **define** each of the variables, **identify** the named functions and quantum numbers, **describe** the functional components and **explain** their origins/relevance.

$$Y_2^{-2}(\theta, \phi) = \frac{1}{4} \sqrt{\frac{15}{2\pi}} \sin^2 \theta e^{-i2\phi}$$

[10 marks]

3. For the "particle in a box" wavefunction given below

$$\psi(x) = N \sin\left(\frac{nx\pi}{L}\right) \text{ with } n = 1, 2, \dots$$

- a) **derive** an expression for the $n=3$ normalisation coefficient. **Show your working.**
- b) **evaluate** N for the $n=3$ level, for a box of length $L=2\text{nm}$. **Show your working**
- c) **sketch** the $n=3$ level probability curve on a diagram of the box

[10 marks]