

Aims and Objectives Quantum Physics I, Session 12

MEASUREMENT IN QUANTUM MECHANICS: DYNAMICAL VARIABLES, OPERATORS, EIGENFUNCTIONS AND EIGENVALUES

Aims (What I intend to do)

- 1) To look at the idea of operators and to indicate how operators for the dynamical variables energy and momentum can be constructed.
- 2) To discuss the relationship between operators, dynamical variables, eigenfunctions and eigenvalues.
- 3) To examine the role operators in eigenvalue equations, and to explain the meaning of eigenvalue equations.
- 4) To discuss the physical significance of eigenfunctions.

Objectives (What you should be able to do after completing the lecture and worksheet)

- 1) To be able to use operators to see if wavefunctions are eigenfunctions of that operator.
- 2) To be able to explain the significance of eigenvalue equations in quantum mechanics.

Quantum Physics 1 PHY2002 Worksheet 12

Task 1. Go over your lecture notes and read section 4.1 and 4.2 of Rae if you wish.

Task 2. Show that the function $\Psi = \exp\left(\frac{i}{\hbar}Et\right)$ is an eigenfunction of the energy operator \hat{E} .

Task 3. Show that the functions,

$$\Psi_1(x,t) = \cos\left(\frac{i}{\hbar}(px - Et)\right)$$
$$\Psi_2(x,t) = \sin\left(\frac{i}{\hbar}(px - Et)\right)$$

are not eigenfunctions of the energy operator. However, show that the combination,

$$\Psi_1 + i\Psi_2$$

is an eigenfunction of \hat{E} .

Task 4. Background reading for next session, Rae, section 4.3.