

## Homework 9

Optional extra question.

Q9.3. The Hermitian operators  $\hat{x}$  and  $\hat{p}$  satisfy

$$[\hat{x}, \hat{p}] = i \quad (\text{Q9.3.1})$$

and

$$\hat{x} |x\rangle = x |x\rangle \quad (\text{Q9.3.2})$$

Express  $\hat{p}$  as a differential operator  $p_x$ . Calculate

$$e^{ia\hat{p}} |x\rangle \quad (\text{Q9.3.3})$$

and

$$e^{iap_x} \phi(x) \quad (\text{Q9.3.4})$$