

### 1 Dirac Practice

For this problem, use the vectors  $|a\rangle = 4|1\rangle - 3|2\rangle$  and  $|b\rangle = -i|1\rangle + |2\rangle$ .

- (a) Find  $\langle a|b\rangle$  and  $\langle b|a\rangle$ . Discuss how these two inner products are related to each other.
- (b) For  $\hat{Q} \doteq \begin{pmatrix} 2 & i \\ -i & -2 \end{pmatrix}$ , calculate  $\langle 1|\hat{Q}|2\rangle$ ,  $\langle 2|\hat{Q}|1\rangle$ ,  $\langle a|\hat{Q}|b\rangle$  and  $\langle b|\hat{Q}|a\rangle$ .
- (c) What kind of mathematical object is  $|a\rangle\langle b|$ ? What is the result if you multiply a ket (for example,  $|a\rangle$  or  $|1\rangle$ ) by this expression? What if you multiply this expression by a bra?