Q.1–4 The spin state of an electron is represented by the spinor

$$\mathbf{a} = [0.6\mathrm{i} \quad 0.8]^T.$$

The operator corresponding to the component of spin in the y-direction is represented by the matrix

$$S_y = \tfrac{1}{2}\hbar \begin{bmatrix} 0 & -\mathrm{i} \\ \mathrm{i} & 0 \end{bmatrix},$$

whose eigenvectors are

$$\mathbf{e}_+ = \frac{1}{\sqrt{2}}[1 \quad \mathrm{i}]^T \quad \text{and} \quad \mathbf{e}_- = \frac{1}{\sqrt{2}}[\mathrm{i} \quad 1]^T$$

corresponding to the eigenvalues $S_y = \frac{1}{2}\hbar$ and $S_y = -\frac{1}{2}\hbar$, respectively.

(i) Select the **ONE** option from the key that is equal to the probability that a measurement of S_y made on this state will yield the value $\frac{1}{2}\hbar$. ☐

(ii) Select the **ONE** option from the key that is equal to $\langle S_y \rangle/\hbar$ for this state. ☐

(iii) Select the **ONE** option from the key that is equal to $\langle S_y^2 \rangle/\hbar^2$ for this state. ☐

(iv) Select the **ONE** option from the key that is equal to $\Delta(S_y)/\hbar$ for this state. ☐

KEY for Q.1–4 (i) to (iv)

A	−0.98	E	−0.02	I	0.25
B	−0.48	F	0.02	J	0.48
C	−0.14	G	0.04	K	0.50
D	−0.04	H	0.14	L	0.98

Q.1–5

(i) Choose the **TWO** options from the key that commute with the operator $\hat{\mathrm{x}}$. ☐☐

(ii) Choose the **TWO** options from the key that commute with the operator $\hat{\mathrm{p}}_x$. ☐☐

KEY for Q.1–5 (i) and (ii)

A	$\hat{\mathrm{x}}^2$	E	$\hat{\mathrm{x}}\hat{\mathrm{p}}_x$
B	$\hat{\mathrm{p}}_x^2$	F	$\hat{\mathrm{p}}_x\hat{\mathrm{x}}$
C	$\hat{\mathrm{p}}_x^2 + \hat{\mathrm{x}}^2$	G	$\hat{\mathrm{x}}\hat{\mathrm{p}}_x + \hat{\mathrm{p}}_x\hat{\mathrm{x}}$
D	$\hat{\mathrm{p}}_x^2 - \hat{\mathrm{x}}^2$	H	$\hat{\mathrm{x}}\hat{\mathrm{p}}_x - \hat{\mathrm{p}}_x\hat{\mathrm{x}}$
