

# 5.73

## Quiz 23

$$\mathbf{J}^2 |JM\rangle = \hbar^2 J(J+1) |JM\rangle$$

$$\mathbf{J}_z |JM\rangle = \hbar M |JM\rangle$$

$$\mathbf{J}_\pm = \mathbf{J}_x \pm i\mathbf{J}_y$$

$$\mathbf{J}_\pm |JM\rangle = [J(J+1) - M(M \pm 1)]^{1/2} |JM \pm 1\rangle$$

A. What are the  $\Delta J$  and  $\Delta M$  selection rules for the following operators:

(i)  $\mathbf{J}^4$

(ii)  $(\mathbf{J}_+)^2$

(iii)  $\mathbf{J}_+\mathbf{J}_-$

(iv)  $\mathbf{J}_x$

(v)  $\bar{\mathbf{J}}$

B. What are the values of the following matrix elements:

(i)  $\langle JM+1 | \mathbf{J}^2 | JM \rangle$

(ii)  $\langle JM | \mathbf{J}^2 \mathbf{J}_z | JM \rangle$

(iii)  $\langle JM | \mathbf{J}_+ \mathbf{J}_- | JM \rangle$

(iv)  $\langle JM | \mathbf{J}_+ \mathbf{J}_- - \mathbf{J}_- \mathbf{J}_+ | JM \rangle$

(v)  $\langle JM+1 | \mathbf{J}_x | JM \rangle$

C. What is the value of the commutator  $[\mathbf{J}_+, \mathbf{J}_-] = ?$

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