$$[\hat{p}_m, \hat{L}_n] = [\hat{p}_m, \epsilon_{nab}\hat{r}_a\hat{p}_b] = \epsilon_{nab}\hat{r}_a[\hat{p}_m, \hat{p}_b] + \epsilon_{nab}[\hat{p}_m, \hat{r}_a]\hat{p}_b = \epsilon_{nab}\hat{p}_b(i\hbar)\delta_{ma} = \epsilon_{mnb}\hat{p}_b\, i\hbar$$

$$[\hat{r}_m, \hat{L}^2] = [\hat{r}_m, \hat{L}_a\hat{L}_a] = \hat{L}_a[\hat{r}_m, \hat{L}_a] + [\hat{r}_m, \hat{L}_a]\hat{L}_a =$$

$$= \hat{L}_a\, i\hbar\, \epsilon_{mab}\hat{r}_b + i\hbar\,\epsilon_{mab}\hat{r}_b\hat{L}_a = i\hbar\,\epsilon_{mab}[\hat{L}_a\hat{r}_b + \hat{r}_b\hat{L}$$

$$= \frac{1}{2}i\hbar\,\epsilon_{mab}\left(\hat{L}_a\hat{r}_b - \hat{L}_b\hat{r}_a + \hat{r}_b\hat{L}_a - \hat{r}_a\hat{L}_b\right) = \frac{1}{2}(i\hbar)\epsilon_{mab}($$

$$= i\hbar\,\epsilon_{mab}\left(\hat{L}_a\hat{r}_b + \hat{r}_b\hat{L}_a\right) \quad \text{nothing very simple}$$

$$[\hat{p}_m, \hat{L}^2] = [\hat{p}_m, \hat{L}_a\hat{L}_a] = \hat{L}_a[\hat{p}_m, \hat{L}_a] + [\hat{p}_m, \hat{L}_a]\hat{L}_a$$

$$= \hat{L}_a\,\epsilon_{mab}\hat{p}_b\, i\hbar + \epsilon_{mab}\hat{p}_b\hat{L}_a\, i\hbar$$

$$= i\hbar\,\epsilon_{mab}\left[\hat{L}_a\hat{p}_b + \hat{p}_b\hat{L}_a\right] \quad \text{nothing simple.}$$

$$[\hat{r}^2, \hat{L}_k] = \hat{r}_a[\hat{r}_a, \hat{L}_k] + [\hat{r}_a, \hat{L}_k]\hat{r}_a = i\hbar\,\epsilon_{akb}\hat{r}_a\hat{r}_k$$

$$+ i\hbar\,\epsilon_{akb}\hat{r}_b\hat{r}_a = 0 \quad \Leftrightarrow \quad \epsilon_{kab}\hat{r}_a\hat{r}_k = 0$$

$$[\hat{p}^2, \hat{L}_k] = \hat{p}_a[\hat{p}_a, \hat{L}_k] + [\hat{p}_a, \hat{L}_k]\hat{p}_a = i\hbar\,\epsilon_{akb}\hat{p}_a\hat{p}_b$$

$$+ i\hbar\,\epsilon_{akb}\hat{p}_b\hat{p}_a = 0$$