1. Test the code for C.G. coefficients for $0 \leq j_1, j_2 \leq 2$ with the symmetry relation

$$\begin{pmatrix} j_1 & j_2 & j \\ m_1 & m_2 & m \end{pmatrix} = (-1)^{j_1+j_2-j} \begin{pmatrix} j_1 & j_2 & j \\ -m_1 & -m_2 & -m \end{pmatrix}.$$

   Your code should write all possible $j_1, j_2, j, m_1, m_2, m, (-1)^{j_1+j_2-j}$ and the ratio between the above two C.G. coefficients obtained from the calculations.

2. For an electric radiation of multipole order 2, the transition strength B(E2)in terms of the transition quadrupole moments (Q_t) according to rotational formula is given by

$$B(E2; I \to I-2) = \frac{5}{16\pi} Q_t^2 \begin{pmatrix} I & 2 & I-2 \\ K & 0 & K \end{pmatrix}^2.$$

   Assuming the values of Q_t for various transitions listed in the following table, verify the theoretical results for $B(E2)$.

   Transition probabilities of ^{71}As

Transition $I_i^\pi \to I_f^\pi$	Q_t $(e fm^2)$	$B(E2; I \to I-2)$ $(e^2 fm^4)$ Theory	Expt.
$\frac{17}{2}^+ \to \frac{13}{2}^+$	224	1345.64	1344.42(384.12)
$\frac{21}{2}^+ \to \frac{17}{2}^+$	202	1211.83	1204.74(628.56)
$\frac{25}{2}^+ \to \frac{21}{2}^+$	174	951.83	960.30(453.96)
$\frac{17}{2}^- \to \frac{13}{2}^-$	210	1182.69	1187.28(218.25)
$\frac{21}{2}^- \to \frac{17}{2}^-$	208	1284.89	1292.04(366.66)
$\frac{25}{2}^- \to \frac{21}{2}^-$	204	1308.34	1309.50(541.26)

3. The total energy (E) of a nucleus is given in terms of single-particle energies (e_i) is given by $E = \sum_{i=1}^{A} e_i$. Assuming that the Hamiltonian to be that of an anisotropic harmonic oscillator with deformation δ_{osc}, plot E (in MeV) versus δ_{osc} for ^{90}Zr.

4. An electric multipole moment representing a multipole radiation of order l, m is given by

$$Q_{lm} = \int r^l Y_{lm}^*(\theta, \phi) \rho(r, \theta, \phi) d\tau.$$

   Calculate Q_{20} for the following cases

   (a) $\rho(r, \theta, \phi) = \rho_0, \quad \forall r < R$ and zero otherwise.

   (b) $\rho(r, \theta, \phi) = \rho_0 \sin\theta, \quad \forall r < R$ and zero otherwise.