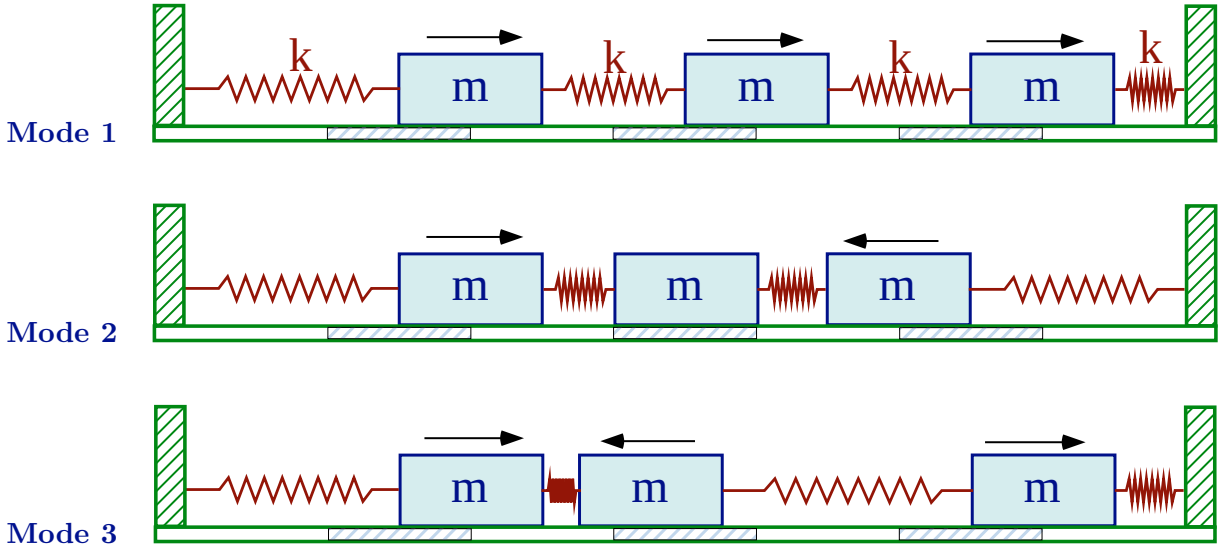
25.5 Mode dance

A ***mode*** is a manner of motion. This section gives a physically meaningful demonstration of eigenvalues and eigenvectors (mode/motion shapes) of a simple three particle system connected by springs.

The mode dance can be done with three people, each who act out a particle's motion and together imitate each mode of the three particle system. Alternatively, it can be done individually with two fists (one particle on either side of your head) and your head (middle particle). Music may accompany each mode. The 1^{st} mode song has a slow beat (e.g., Enya's Caribbean Blue). The 2^{nd} mode song has a medium beat (e.g., Star Wars). The 3^{rd} mode song has a fast beat (e.g., William Tell Overture).



Under the columns labeled "Eigenvalue," "Kinetic Energy," and "Total Energy," circle or write **small**, **medium**, or **large**. Under the column labeled "Eigenvector," write **+**, **0**, or **−**.

Mode #	Eigenvalue (frequency)	Eigenvector (use + 0, or −)	Potential Energy ($\frac{1}{2}\,k\,\delta^2$)	Kinetic Energy ($\frac{1}{2}\,m\,v^2$)	Total Energy
1	**small medium large**	$\begin{bmatrix}+\\ \\ \end{bmatrix}$ or $\begin{bmatrix}-\\ \\ \end{bmatrix}$	**small**/**medium**/**large** **2**/**3**/**4** deformed springs **small** deformation	**small/medium/large** speed **1**/**2**/**3** particles moving	**small medium large**
2	**small medium large**	$\begin{bmatrix}+\\ \\ \end{bmatrix}$ or $\begin{bmatrix}-\\ \\ \end{bmatrix}$	**small**/**medium**/**large** **2**/**3**/**4** deformed springs **medium** deformation	**small/medium/large** speed **1**/**2**/**3** particles moving	**small medium large**
3	**small medium large**	$\begin{bmatrix}+\\ \\ \end{bmatrix}$ or $\begin{bmatrix}-\\ \\ \end{bmatrix}$	**small**/**medium**/**large** **2**/**3**/**4** deformed springs **large** deformation	**small/medium/large** speed **1**/**2**/**3** particles moving	**small medium large**

Answers at www.MotionGenesis.com ⇒ Textbooks ⇒ Resources.

Optional: Vocabulary for next section (Section 25.6)

M	Mass matrix	K	Stiffness matrix	F	Forcing function matrix
X_i	Physical coordinate	Q_i	Modal coordinate	$\bar{F}$	Normalized forcing function matrix
λ_i	Eigenvalue	v_i	Eigenvector	s_i	Normalizing constant with respect to M
ω_i	Natural frequency	A_i	Normalized eigenvector	A	Modal matrix normalized with respect to M