1.2 a) Vector q is the axis of rotation for the 3D rotation.

b) An eigenvector must satisfy $Aq = \lambda q$, hence it is not thrown off its span during the transformation. The axis of rotation, and all the vectors along the axis, remain on their span after the transformation.

c) If $\lambda \neq 1$, then it means the eigenvector was scaled (shrunk or stretched). We expect proportions and scale to be preserved during rotation, and so this is not a proper rotation.