1. (a) Find the $2 \times 2$ matrix $A$ corresponding to the linear transformation of projecting onto the line $y = 3x$.

(b) What is $A^2$? Is there a geometric reason for this?

(c) Suppose $P$ is an $n \times n$ matrix corresponding to the linear transformation of projecting onto a subspace $W \subset \mathbb{R}^n$. What are the possible eigenvalues of $P$?

2. An $n \times n$ matrix $Q$ is called orthogonal if its columns are orthonormal.

(a) Prove that if $Q$ is orthogonal, then $Q$ is invertible and $A^{-1} = A^T$.

(b) Prove that if $Q$ is orthogonal, then

$$(Qv, Qw) = (v, w)$$

for any two vectors $v$ and $w$ in $\mathbb{R}^n$. 