Definition: A **vector space** is a nonempty set of objects V, called vectors, which have two operations defined: addition of vectors and multiplication by scalars (real numbers). For all $u, v, w \in V$ and for all scalars c, d,the following ten axioms must hold:

1. $u + v \in V$
2. $u + v = v + u$
3. $(u + v) + w = u + (v + w)$
4. There exists a vector $0 \in V$ such that $u + 0 = u$
5. For all $u \in V$, there is a vector $-u \in V$ such that $u + (-u) = 0$
6. $cu \in V$
7. $c(u + v) = cu + cv$
8. $(c + d)u = cu + cd$
9. $c(du) = (cd)u$
10. $1u = u$

Determine if the following subsets H are subspaces of the vector space V.

1. H is the x-axis, $V = \mathbb{R}^3$
2. H is the line $x = 2$, $V = \mathbb{R}^2$
3. H is the first octant, $V = \mathbb{R}^3$
4. $H = \left\{ p(t) \in \mathbb{P}_4 \mid p(t) = a + bt^4 \right\}$, $V = \mathbb{P}_4$
5. $H = \left\{ p(t) \in \mathbb{P}_4 \mid p(t) = 1 + bt^4 \right\}$, $V = \mathbb{P}_4$

Let $A = \begin{bmatrix} 1 & 0 & 3 \\ 2 & 1 & -1 \\ 4 & 1 & 5 \end{bmatrix}$.

1. Find an explicit algebraic description for $nul(A)$.

   What is the geometric interpretation?

2. Find an explicit algebraic description for $col(A))$.

   What is the geometric interpretation?