Exercise 1. Short answers:

1. If $\vec{u}$ and $\vec{v}$ are parallel, what is the algebraic relation between them?
2. Suppose a line ℓ is normal to a plane π. What is the relation between $\vec{v}_\ell$ and $\vec{n}_\pi$?
3. If $f\colon\mathbb{R}^3\to\mathbb{R}$ is a function, how many components does its gradient ∇f have?
4. If $\nabla f(\vec{a})\cdot\vec{u}<0$, does f increase or decrease in the direction of $\vec{u}$ at $\vec{a}$?
5. If f has $\det Hf>0$ and $f_{xx}>0$ at $\vec{x}=\vec{a}$, can you conclude if f has a maximum, minimum, or saddle point at $\vec{a}$?

Exercise 2. Consider the function $f(x,y) = 8x + 8y$ on the region described by $\{4x^2 = y^2 - 1\}$. There are two critical points. Follow these steps to classify them:

1. Identify the function f you're optimizing.
2. Identify the constraint as $g = 0$.
3. Write the Lagrange equation: $\nabla f = \lambda \nabla g$.
4. Solve for $\vec{x}$ in terms of λ, then use $g = 0$ to find λ.
5. Find $\vec{x}$ using λ and classify the points by evaluating f.