Name __________________________________________

- No calculators allowed.
- Show sufficient work to justify each answer.
- You have 15 minutes for this quiz.

1. (4 points) Let the point $P = (1, -\sqrt{3}, 2\sqrt{3})$ be given in rectangular coordinate. Express this point in terms of both cylindrical and spherical coordinates.

\[ Cylindrical \]
\[ r = \sqrt{1 + 3 + 9} = 2 \]
\[ \theta = \frac{5\pi}{3} \]
\[ z = 2\sqrt{3} \]

\[ Spherical \]
\[ \rho = \sqrt{1 + 3 + 9} = 4 \]
\[ \theta = \frac{5\pi}{3} \] (from cylindrical coord.)
\[ \rho \cos \phi = z \Rightarrow \cos \phi = \frac{\sqrt{3}}{b} \Rightarrow \phi = \frac{\pi}{6} \]