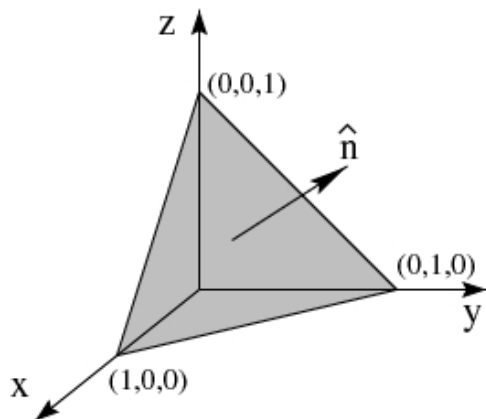




1 Electric Field from a Rod

This is a typical quiz/exam problem. Consider a thin charged rod of length L standing along the z -axis with the bottom end on the xy -plane. The charge density λ is constant. Find the electric field at the point $(0, 0, 2L)$.

2 Electric Field Due to a Ring - Limiting Cases

If you need more practice with series problems. In class, we considered the electric field due to a charged ring with total charge Q and radius R .

Find the first two non-zero terms of a series expansion for the electric field at each of these special locations:

(a)

$$\vec{E}(\vec{r}) = \frac{kQ}{2\pi} \int \frac{((s \cos \phi - R \cos \phi') \hat{x} + (s \sin \phi - R \sin \phi') \hat{y} + z \hat{z})}{(s^2 + R^2 - 2sR \cos(\phi - \phi') + z^2)^{\frac{3}{2}}} d\phi' \quad (1)$$

Near the center of the ring, on the axis perpendicular to the plane of the ring;

(b) Far from the ring, in the plane of the ring;

3 Cross Triangle

Use the cross product to find the components of the unit vector $\hat{n}$ perpendicular to the plane shown in the figure below, i.e. the plane joining the points $\{(1, 0, 0), (0, 1, 0), (0, 0, 1)\}$.

4 Directional Derivative

You are on a hike. The altitude nearby is described by the function $f(x, y) = kx^2y$, where $k = 20 \frac{\text{m}}{\text{km}^3}$ is a constant, x and y are east and north coordinates, respectively, with units of kilometers. You're standing at the spot (3 km, 2 km) and there is a cottage located at (1 km, 2 km). You drop your water bottle and the water spills out.

- (a) Plot the function $f(x, y)$ and also its level curves in your favorite plotting software. Include images of these graphs. Special note: If you use a computer program written by someone else, you must reference that appropriately.
- (b) In which direction in space does the water flow?
- (c) At the spot you're standing, what is the slope of the ground in the direction of the cottage?
- (d) Does your result to part (c) make sense from the graph?