

at $y = 1$ and the negative charge at $y = -1$. Again, singularities at $(x, y) = (0, \pm 1)$ are not shown.

1.11 Additional Problems

1.11.1 Plotting Vector Fields

Plot the following vector fields:

$$\begin{array}{llll}
 \text{(a)} \ y\hat{\mathbf{i}} - x\hat{\mathbf{j}} & \text{(b)} \ \frac{1}{\sqrt{2}}(\hat{\mathbf{i}} - \hat{\mathbf{j}}) & \text{(c)} \ \frac{x\hat{\mathbf{i}} + y\hat{\mathbf{j}}}{\sqrt{2}} & \text{(d)} \ 2y\hat{\mathbf{i}} \quad \text{(e)} \ x^2\hat{\mathbf{i}} + y^2\hat{\mathbf{j}} \\
 \text{(f)} \ \frac{y\hat{\mathbf{i}} - x\hat{\mathbf{j}}}{\sqrt{x^2 + y^2}} & \text{(g)} \ xy\hat{\mathbf{i}} - x\hat{\mathbf{j}} & \text{(h)} \ \cos x\hat{\mathbf{i}} + \sin y\hat{\mathbf{j}} &
 \end{array}$$

1.11.2 Position Vector in Spherical Coordinates

In spherical coordinates (see Figure 1.2.3), show that the position vector can be written as

$$\vec{\mathbf{r}} = r \sin \theta \cos \phi \hat{\mathbf{i}} + r \sin \theta \sin \phi \hat{\mathbf{j}} + r \cos \theta \hat{\mathbf{k}}$$

1.11.3 Electric Field

A charge $+1$ is situated at the point $(-1, 0, 0)$ and a charge -1 is situated at the point $(1, 0, 0)$. Find the electric field of these two charges at an arbitrary point $(0, y, 0)$ on the y -axis.

1.11.4 An Object Moving in a Circle

A particle moves in a circular path of radius r in the xy -plane with a constant angular speed $\omega = d\theta/dt$. At some instant t , the particle is at P , as shown in Figure 1.11.1.