

# Potentials and Fields Near Electric Charge.

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In[*]:= (*Initialization*)
dx = 0.1;
dy = dx;
dz = dx;
xmax = 1;
xmin = -1;
xlist = Range[xmin, xmax, dx];
ylist = xlist;
zlist = xlist;
lx = Length[xlist];
V = ConstantArray[0, {lx, lx, lx}];
ρ = ConstantArray[0, {lx, lx, lx}];
ρ[(lx + 1) / 2, (lx + 1) / 2, (lx + 1) / 2] = 1 / dx^3;

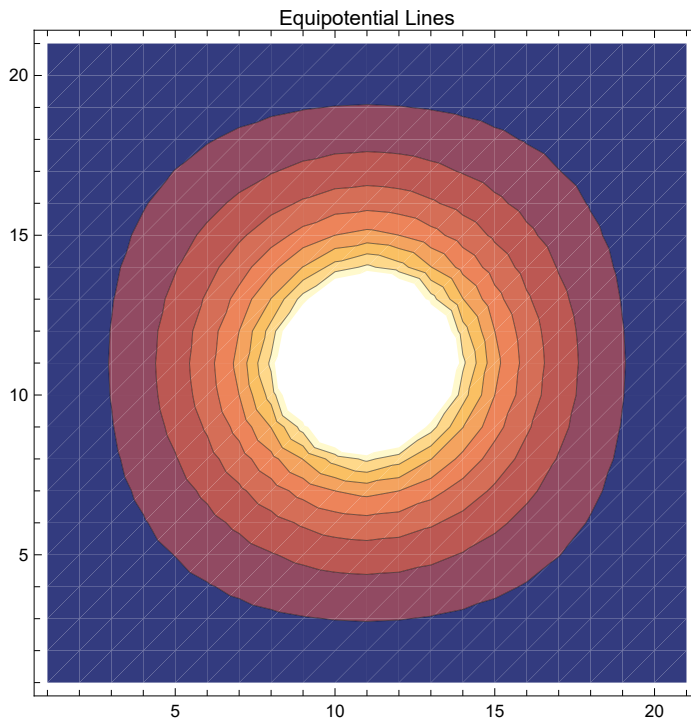
(*Updating V*)
Vold = V;
tol = 1;
k = 1;
While[tol > 0.00001,
  Do[Do[Do[V[[i, j, k]] = ((1 / 6) * (V[[i + 1, j, k]] + V[[i - 1, j, k]] + V[[i, j + 1, k]] +
    V[[i, j - 1, k]] + V[[i, j, k + 1]] + V[[i, j, k - 1]])) +
    ρ[[i, j, k]] * ((dx)^2) / 6, {i, 2, lx - 1}], {j, 2, lx - 1}], {k, 2, lx - 1}];
  dV = Abs[V - Vold];
  tol = Max[dV];
  Vold = V;
  k = k + 1;];
MatrixForm[V];
ListContourPlot[V[[All, All, (lx + 1) / 2]],
  AxesLabel → {"x", "y"}, PlotLabel → "Equipotential Lines"]
ListPlot3D[V[[All, All, (lx + 1) / 2]], PlotRange → All,
  AxesLabel → {"x", "y", "V"}, PlotLabel → "3D Potential Surface"]
(*****)
Ex = 0 * V; (*we wont calculate the E at the boundaries*)
Do[Ex[[i, j, k]] = -((V[[i + 1, j, k]] - V[[i - 1, j, k]] / (2 dx)),
  {j, 2, lx - 1}, {i, 2, lx - 1}, {k, 2, lx - 1}];
MatrixForm[Ex];
Ey = 0 * V; (*we wont calculate the E at the boundaries*)
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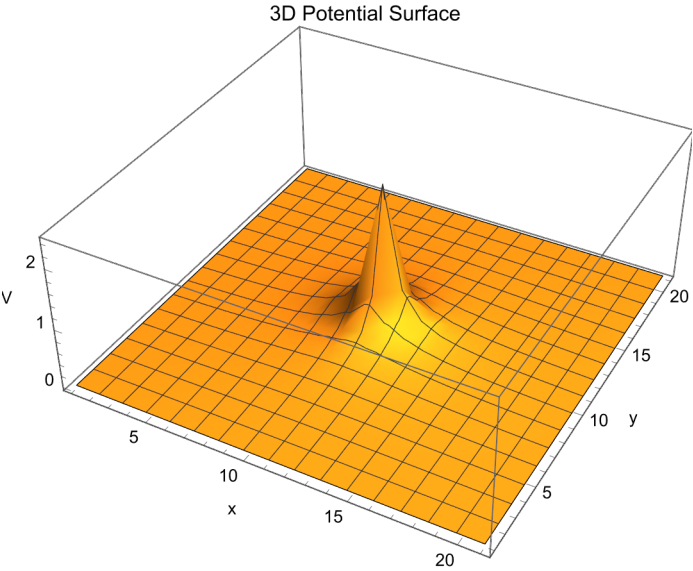
Do[Ey[[i, j, k]] = - ((V[[i, j + 1, k]] - V[[i, j - 1, k]]) / (2 dy)),
  {j, 2, lx - 1}, {i, 2, lx - 1}, {k, 2, lx - 1}];
MatrixForm[Ey];
Ez = 0 * V; (*we wont calculate the E at the boundaries*)
Do[Ez[[i, j, k]] = - ((V[[i, j, k + 1]] - V[[i, j, k - 1]]) / (2 dz)),
  {j, 2, lx - 1}, {i, 2, lx - 1}, {k, 2, lx - 1}];
MatrixForm[Ez];
ListVectorPlot[
  Flatten[Table[{{xlist[[i]], ylist[[j]]}, {Ex[[i, j, (lx + 1) / 2]], Ey[[i, j, (lx + 1) / 2]]}},
    {i, 2, lx - 1}, {j, 2, lx - 1}], 1],
  AxesLabel -> {"x", "y"}, PlotLabel -> "Electric Field Vectors"]

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Out[8]=



Out[8]=



Out[9]=

