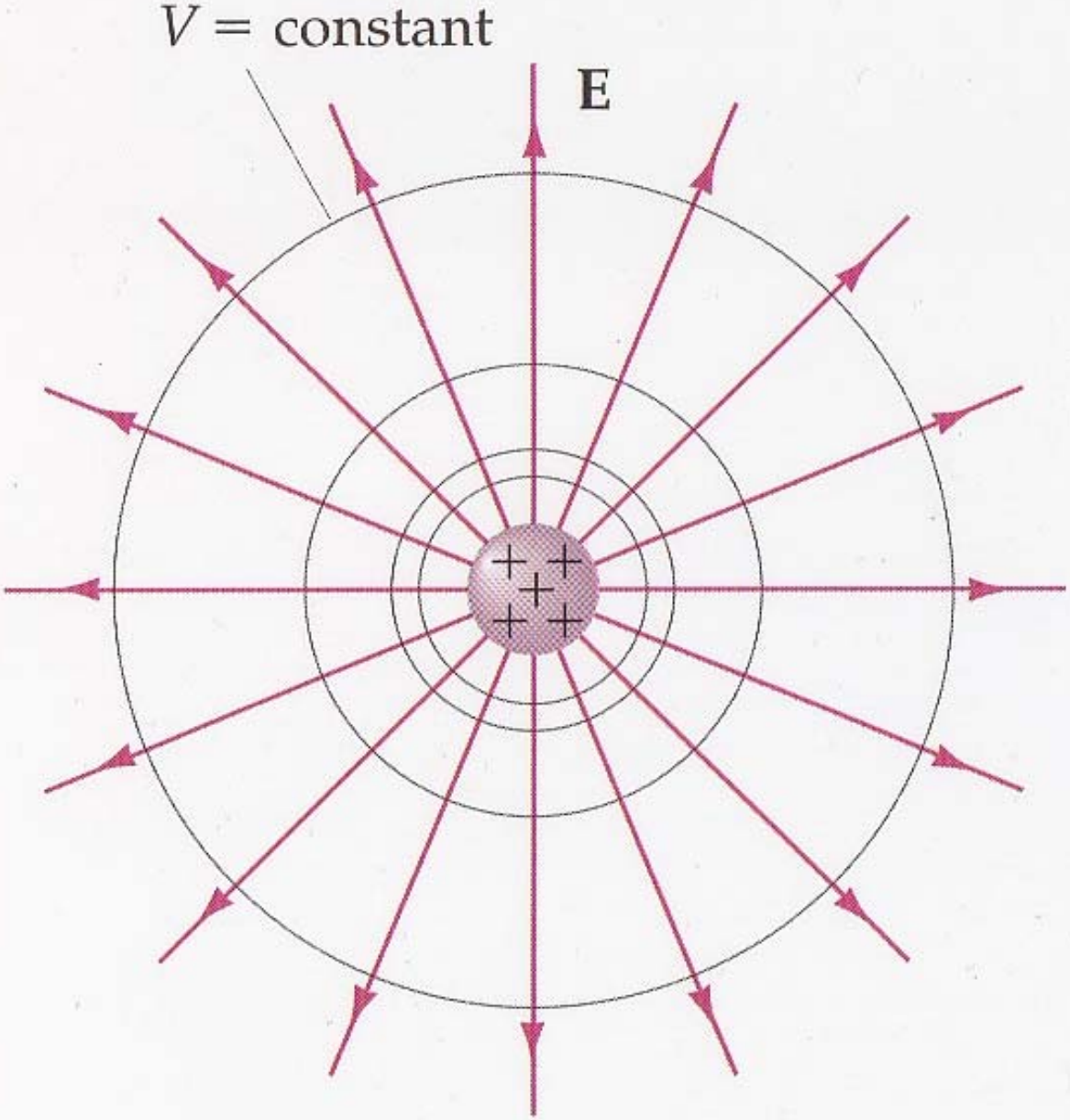
Equipotential Surfaces

- Surface on which electric potential has a constant value. Example: Point charge potential $V = \frac{kQ}{r}$
- All points on spherical surface of radius r centered on Q have same V
- Example: Q=10^{-6}C; what is the 100 V equipotential surface?

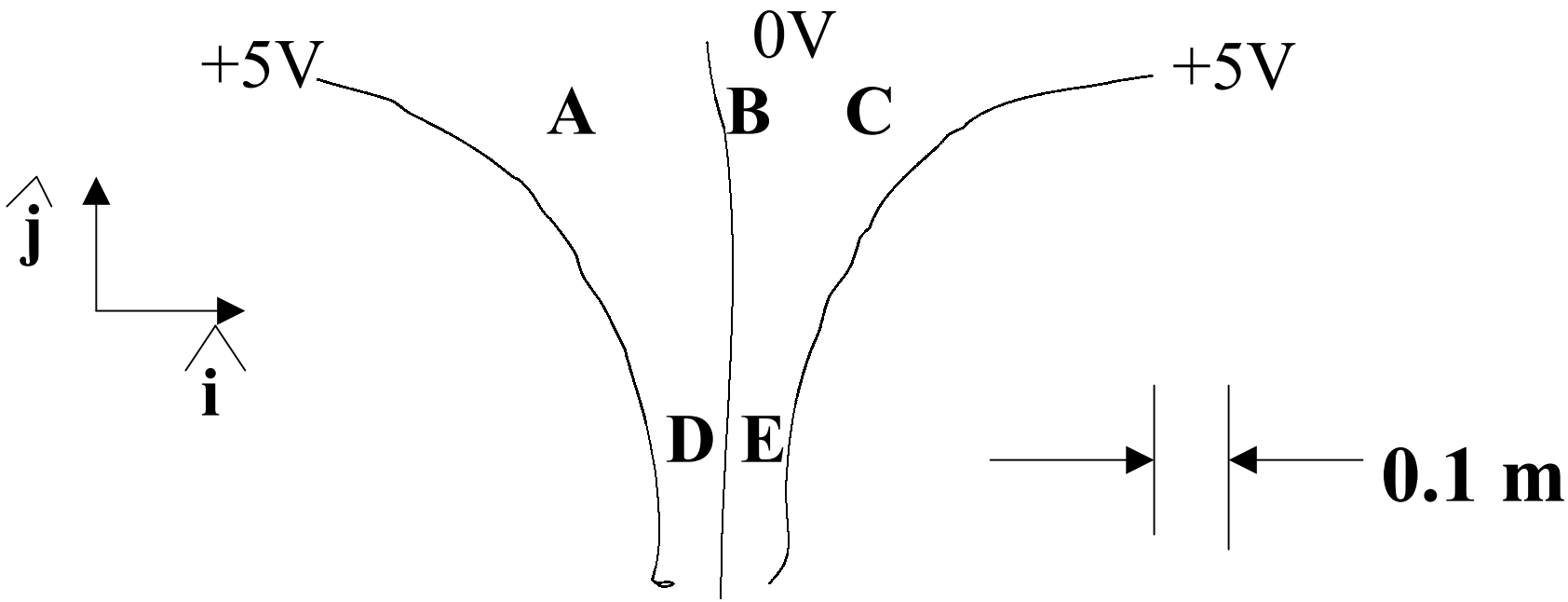
$$r = \frac{kQ}{V} = \frac{(9x10^9\, Nm^2/C^2)(10^{-6}\, C)}{100V} = 90m$$

- So, 100 V equipotential surface is surface of sphere of radius 90 m. For other values of V, get different radii:


V = constant
E

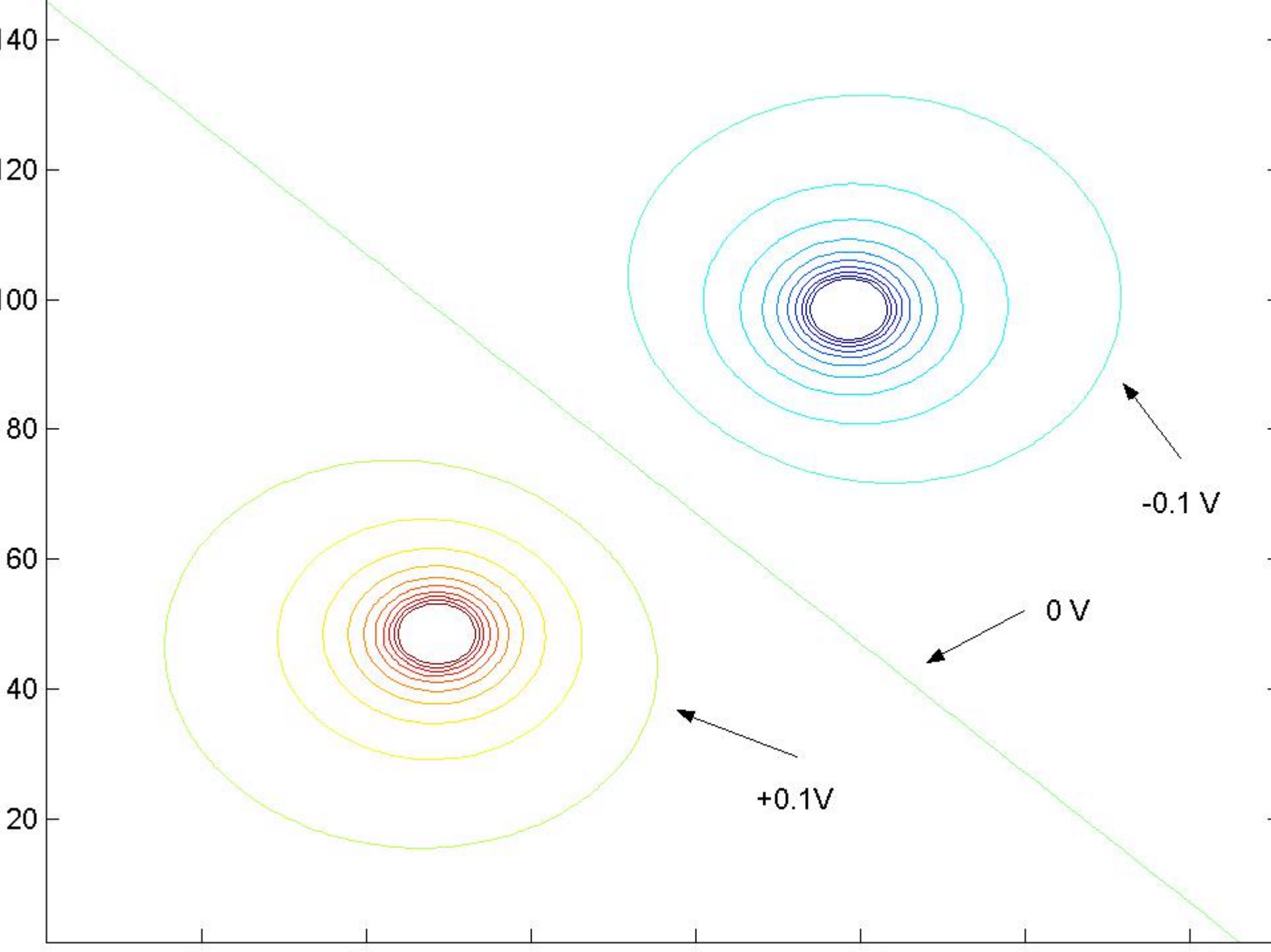
Relation between $\vec{E}$ and Equipotentials

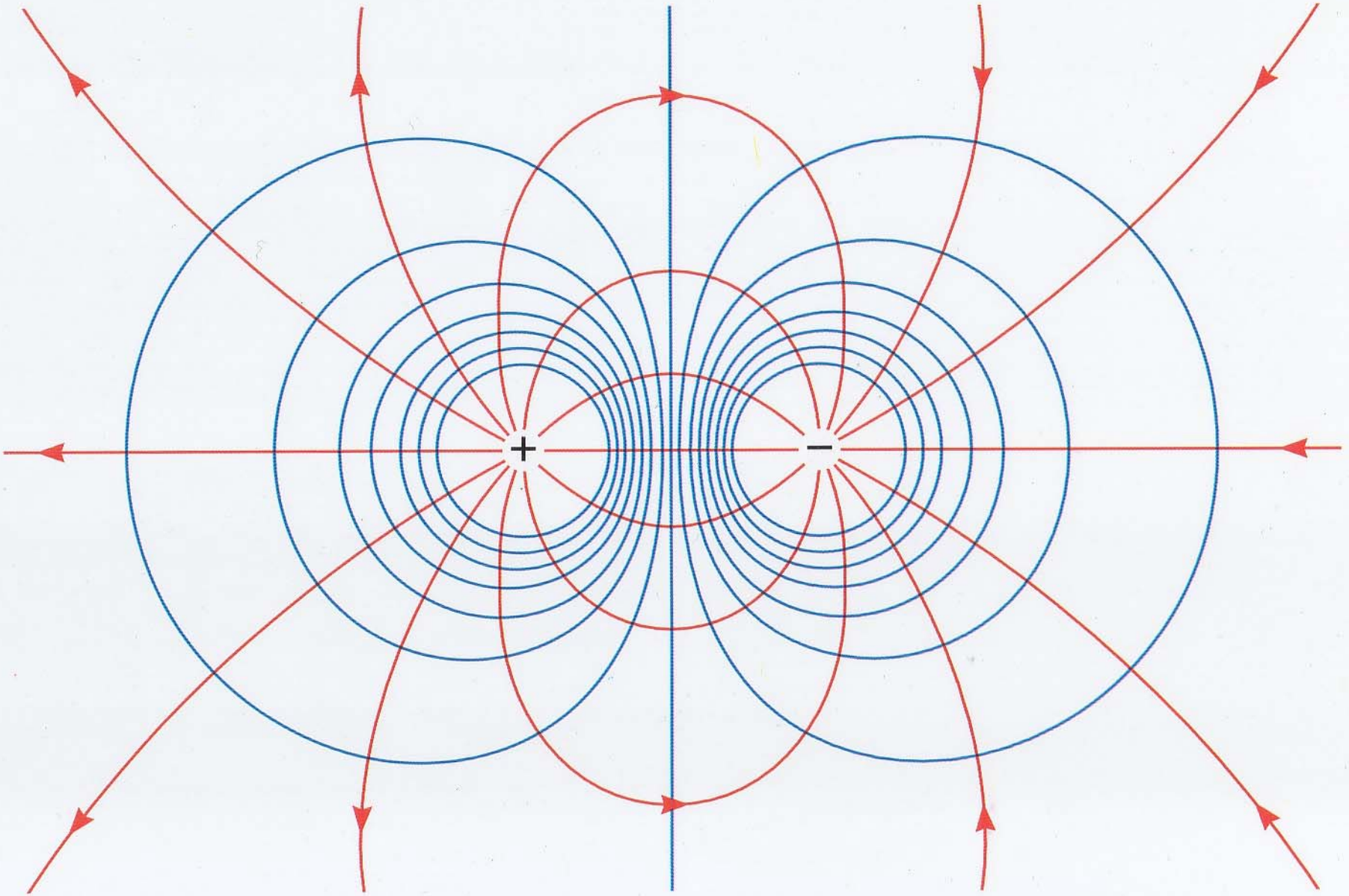
- Remember from last time, $\vec{E}$ points in direction along which V is ***decreasing.*** E is $\perp$ to equipotentials.
- If there is the same potential step between adjacent equipotentials, E is largest where equipotentials are close together.
- For which point below is E large and toward $+\hat{i}$?

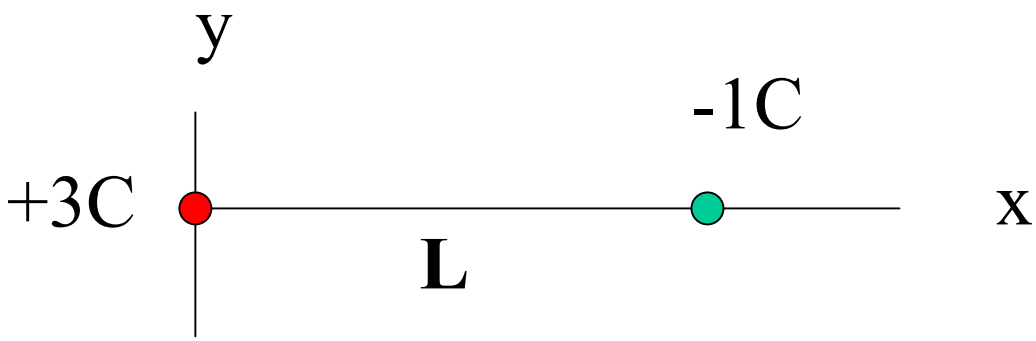


Equipotentials for Set of Point Charges

- Near each charge, equipotentials ≈ spheres
- Far from ***all*** charges, equipotentials ≈ spheres
- Equipotentials are close together where field strong (assuming equal potential steps between equipotentials)
- System with + and - charges will have positive and negative equipotentials
- Question 2 …
- Question 3: Approximate strength of electric field at point D?
- Example equipotentials for one positive point charge and one negative point charge..


140
120
100
80
60
40
20
-0.1 V
0 V
+0.1V





At which point is V = 0?:

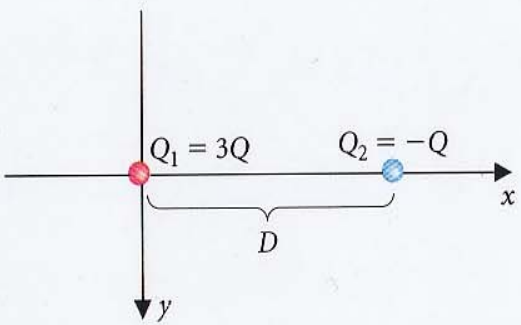
A. x=0

B. x=L/4

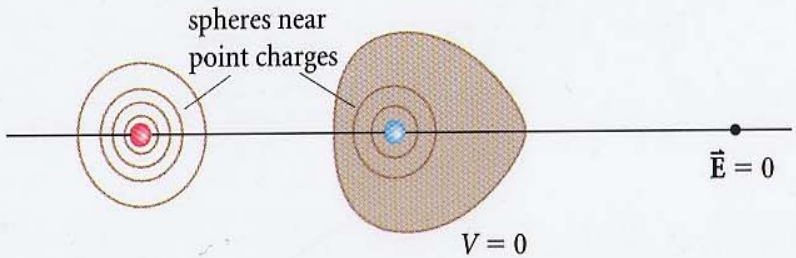
C. x=L/2

D. x=3L/4

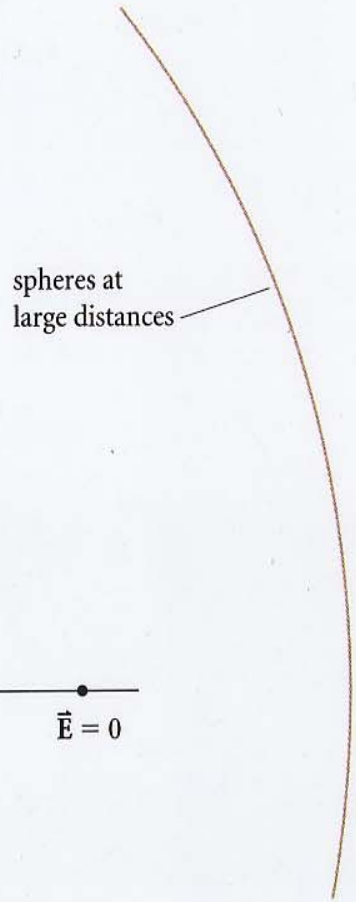
E. x=L

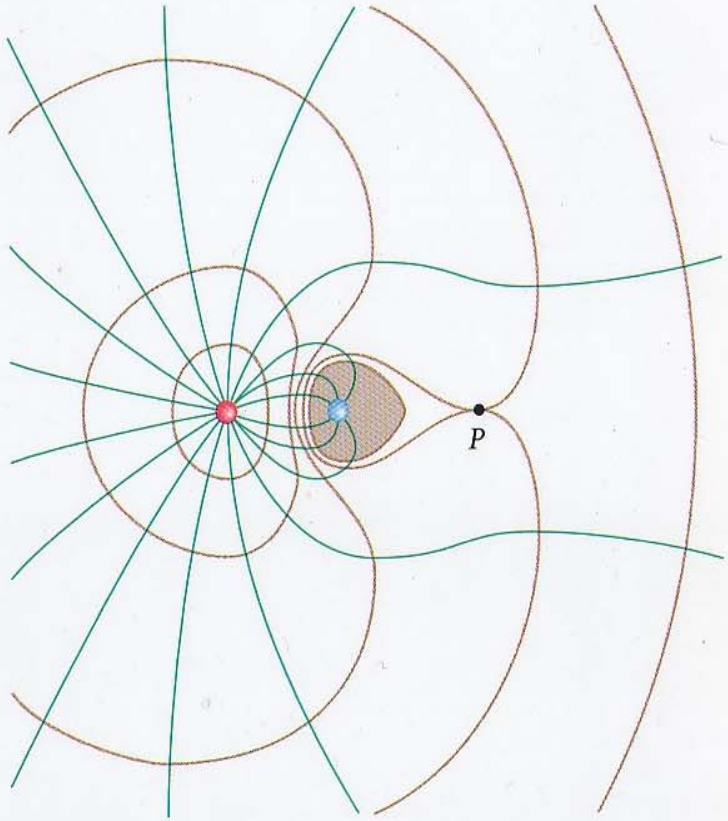

$Q_1 = 3Q$
$Q_2 = -Q$
x
D
y

(a)


spheres near
point charges
$\vec{E} = 0$
$V = 0$

(b)


spheres at
large distances


P

(c)

Equipotentials of Extended Objects

- For symmetric objects, use Gauss's law to get E as function of distance from object, then use

$$V[P] = -\int_{\infty}^{P} \vec{E} \bullet d\vec{l}$$

- Remember the E and V outside the surface of a uniformly charged sphere or spherical shell act like E and V for a point charge at the center
- Question: The electric potential 0.1 m from the surface of a charged sphere of radius 0.2 m is 100V. What is the total charge on the sphere?

Electrical ***Conductors***

- Material in which some of the electrons move freely
- Most good conductors are metals
- "Free" electrons in conductor move until E = 0 everywhere within the material of the conductor