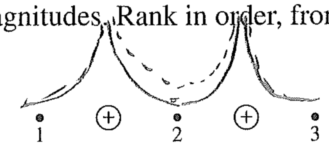
29.7 The Electric Potential of Many Charges

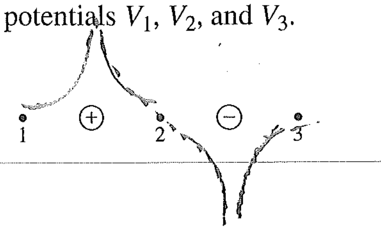
22. Each figure below shows three points in the vicinity of two point charges. The charges have equal magnitudes. Rank in order, from largest to smallest, the potentials V_1, V_2, and V_3.

a.



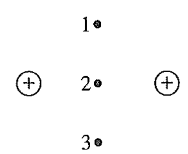
2 (1,3 tie)

b.



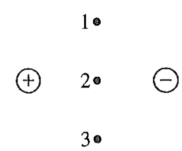
1, 2=0V, 3

c.



2, 3+1 tie

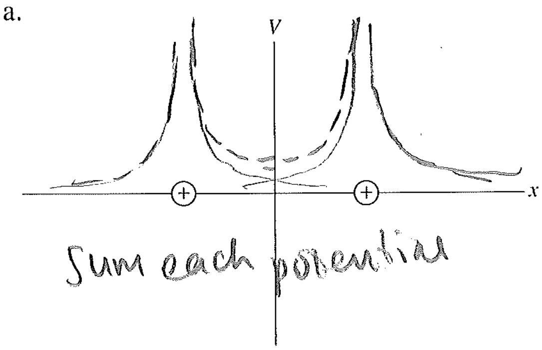
d.



1,2,3 all = 0V.

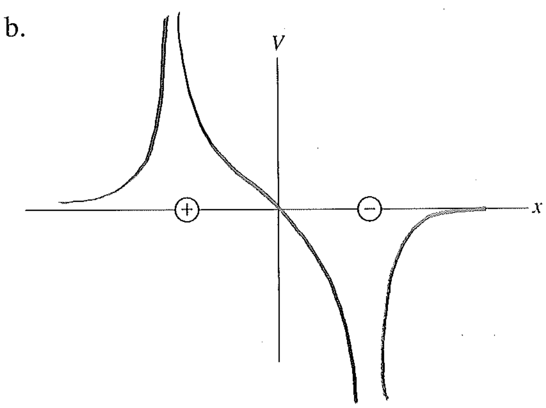
23. On the axes below, draw a graph of V versus x for the two point charges shown.

a.



Sum each potential

b.

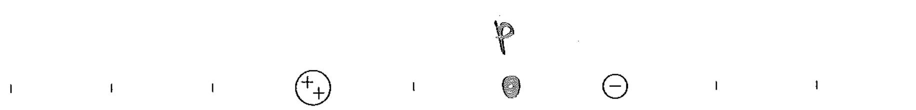


24. For each pair of charges below, are there any points (other than at infinity) at which the electric potential is zero? If so, identify them on the figure with a dot and a label. If not, why not?

a.

No. (+V) + (+V) > 0.

b.



Yes. $\frac{k \cdot 2q}{r_{++}} = \frac{kq}{r_{+}}$ $r_{++} = 2r_{--}$ point P

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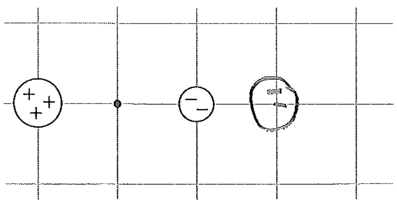
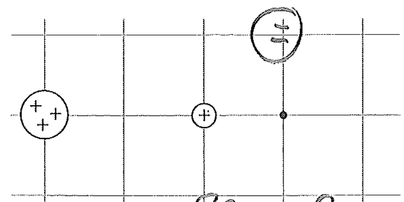
25. For each pair of charges below, at which grid point or points could a double-negative point charge ($q = -2$) be placed so that the potential at the dot is 0 V? There may be more than one possible point. Draw the charge on the figure at all points that work.

a.



b.



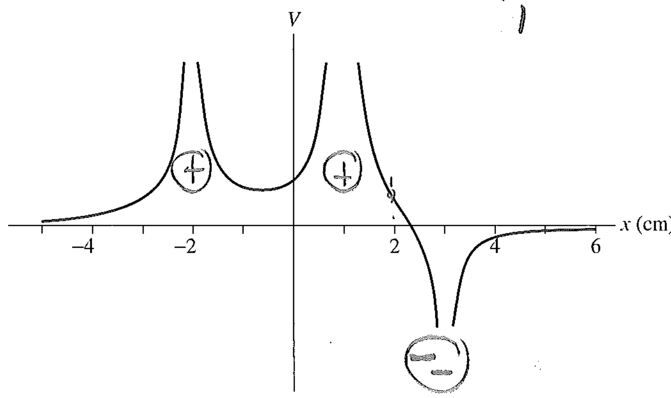
$V \propto \frac{3q}{1} - \frac{2q}{1} = \frac{q}{1}$ adding $-\frac{2q}{2}$ makes ϕ.

$V \propto \frac{3q}{3} + \frac{q}{1} = \frac{2q}{1}$ adding $-\frac{2q}{1}$ makes ϕ.

26. The graph shows the electric potential along the x-axis due to point charges on the x-axis.

a. Draw the charges *on the axis of the figure*. Note that the charges may have different magnitudes.

b. An electron is placed at $x = 2$ cm. Is its potential energy positive, negative, or zero? Explain.



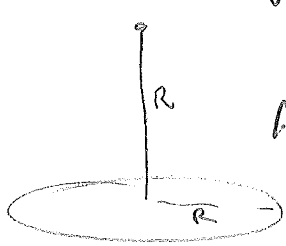
$U < 0$ $U = qV$.

c. If the electron is released from rest at $x = 2$ cm, will it move right, move left, or remain at $x = 2$ cm? Base your explanation on energy concepts.

Left. "Uphill"

27. A ring has radius R and charge Q. The ring is shrunk to a new radius $\frac{1}{2}R$ with no change in its charge. By what factor does the on-axis potential at $z = R$ increase?

$V = \int \frac{k\,dq}{r} = \int \frac{k\,dq}{\sqrt{2}R} = \frac{kQ}{\sqrt{2}R}$



After

$V = \int \frac{k\,dq}{r} = \int \frac{k\,dq}{\sqrt{R^2 + (\frac{1}{2}R)^2}} = \frac{kQ}{\sqrt{\frac{5}{4}R^2}}$

$\frac{V_a}{V_b} = \frac{2\sqrt{2}}{\sqrt{5}} = 1.265.$

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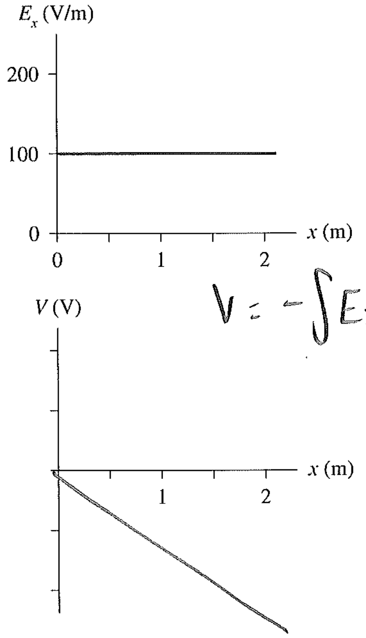
30 Potential and Field

30.1 Connecting Potential and Field

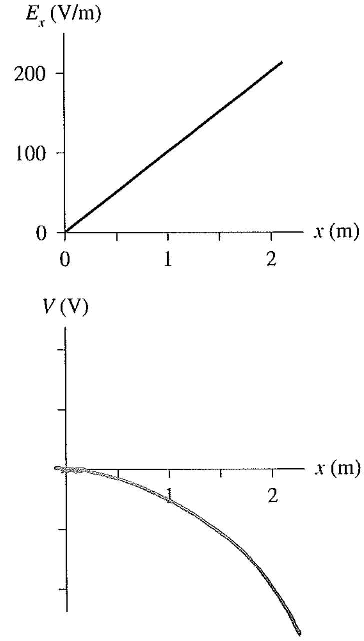
1. The top graph shows the x-component of $\vec{E}$ as a function of x. On the axes below the graph, draw the graph of V versus x in this same region of space. Let $V = 0$ V at $x = 0$ m. Include an appropriate vertical scale. (Hint: Integration is the area under the curve.)

a.



$V = -\int E_x dx$

b.



30.2 Sources of Electric Potential

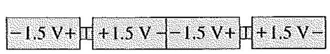
2. What is ΔV_{series} for each group of 1.5 V batteries?

a. 

$\Delta V_{series} =$ 6V.

b. 

$\Delta V_{series} =$ 3V

c. 

$\Delta V_{series} =$ 0V

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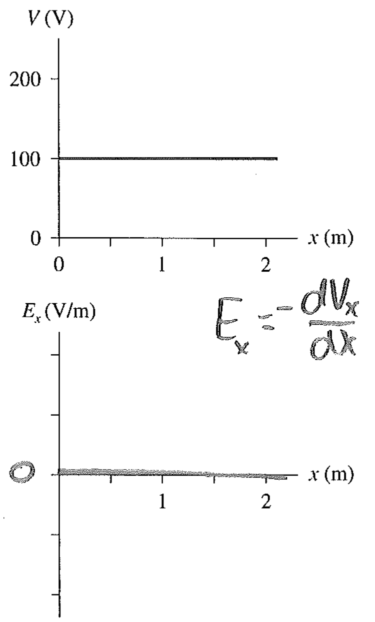
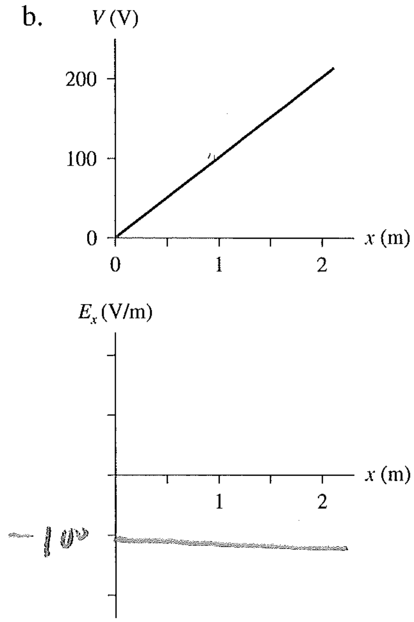
30.3 Finding the Electric Field from the Potential

3. The top graph shows the electric potential as a function of x. On the axes below the graph, draw the graph of E_x versus x in this same region of space. Add an appropriate scale on the vertical axis.

a.

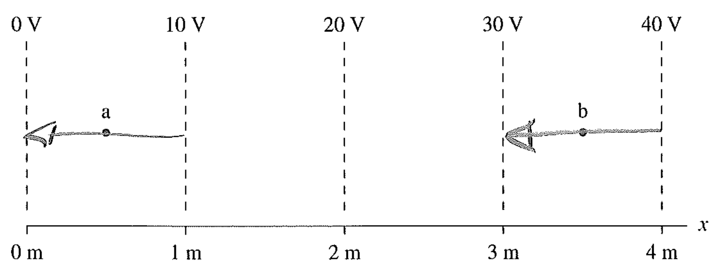


b.



4. For each contour map:
   i. Estimate the electric fields $\vec{E}_a$ and $\vec{E}_b$ at points a and b. Don't forget that $\vec{E}$ is a vector. Show how you made your estimate.
   ii. On the contour map, draw the electric field vectors at points a and b.

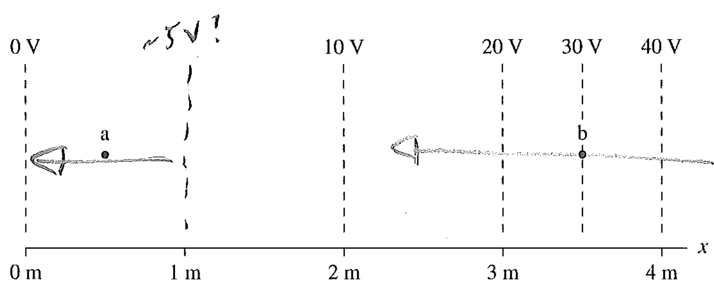
a.



$\vec{E}_a$ = 10 V/m

$\vec{E}_b$ = 10 V/m

b.



$\vec{E}_a$ = 5 V/m

$\vec{E}_b$ = 20 V/m

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