Electric Energy
And
Potential

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A more commonly use units: the *VOLT*.

1 volt (V) = 1 joule/coulomb (J/C)

The point of zero electric potential is taken to be at an infinite distance from the charge.

A potential exists at some point in space whether or not there is a test charge at that point.

Electric potential is a scalar quantity.

Potential difference (ΔV) is often a quantity of interest.

Electric Potential of Multiple Point Charges

The *superposition* principle applies:
The total electric potential at some point P due to several point charges is the *algebraic* sum of the electric potentials due to the individual charges.

The algebraic sum is used because potentials are scalar quantities.

The potential difference between points A and B is defined as the change in the potential energy (final value minus initial value) of a charge *q* moved from A to B divided by the size of the charge.

$$\Delta V = V_B - V_A = \Delta PE / q$$

Potential difference is *not* the same as potential energy.

Another way to relate the energy and the potential difference: $\Delta PE = q\,\Delta V$

Both electric potential energy and potential difference are *scalar* quantities

Units of potential difference

$$\mathrm{V} = \mathrm{J/C}$$

A special case occurs when there is a *uniform electric field*

$$\Delta V = V_B - V_A = -E_x\,\Delta x$$

An equivalent unit for electric field:

$$\mathrm{N/C} = \mathrm{V/m}$$

Potentials and Charged Conductors

Work **is associated with charge movement through a potential difference:**

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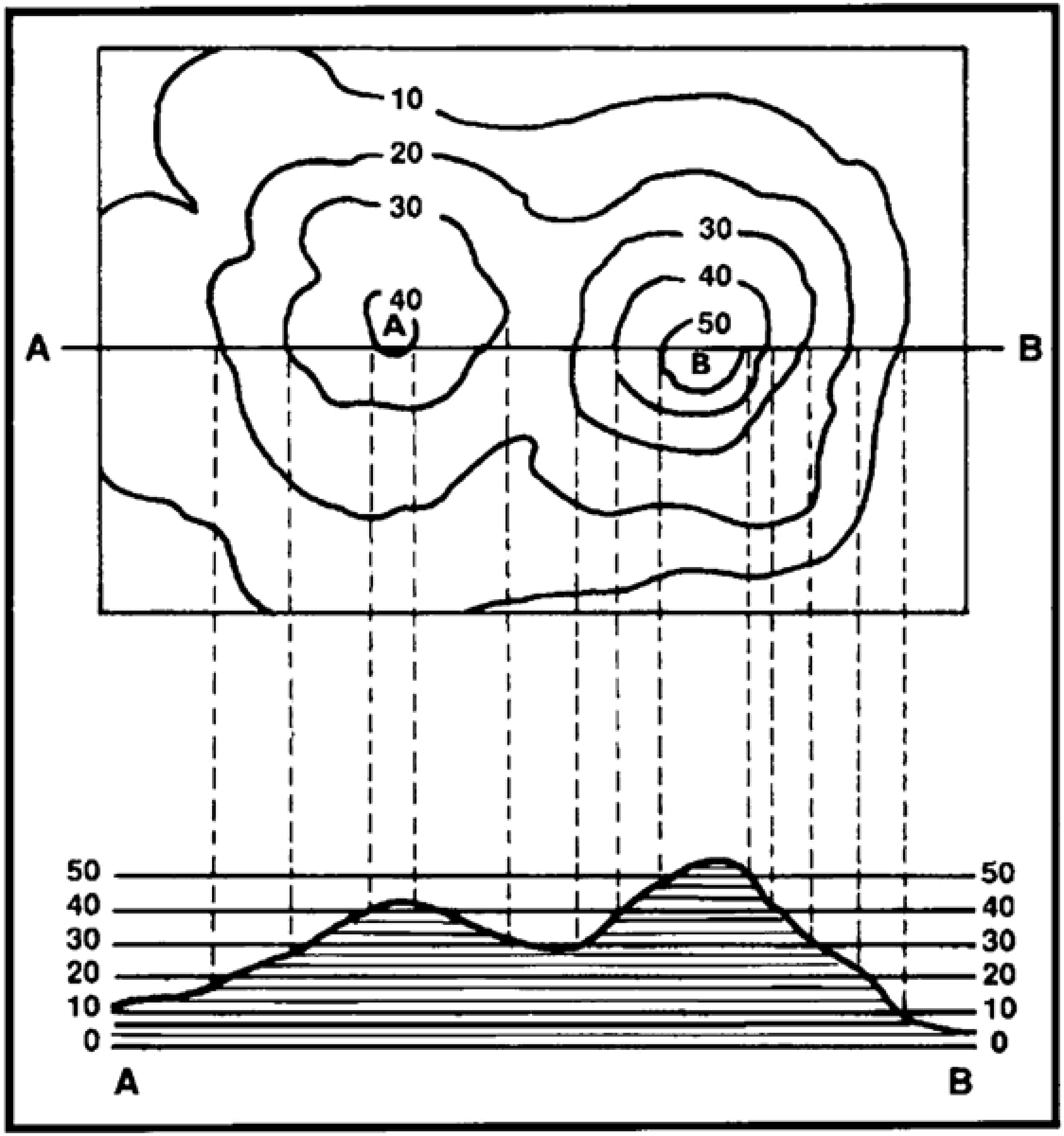
No work **is required to move a charge between two points that are at the same electric potential:**

$W = 0$ **when** $V_A = V_B$

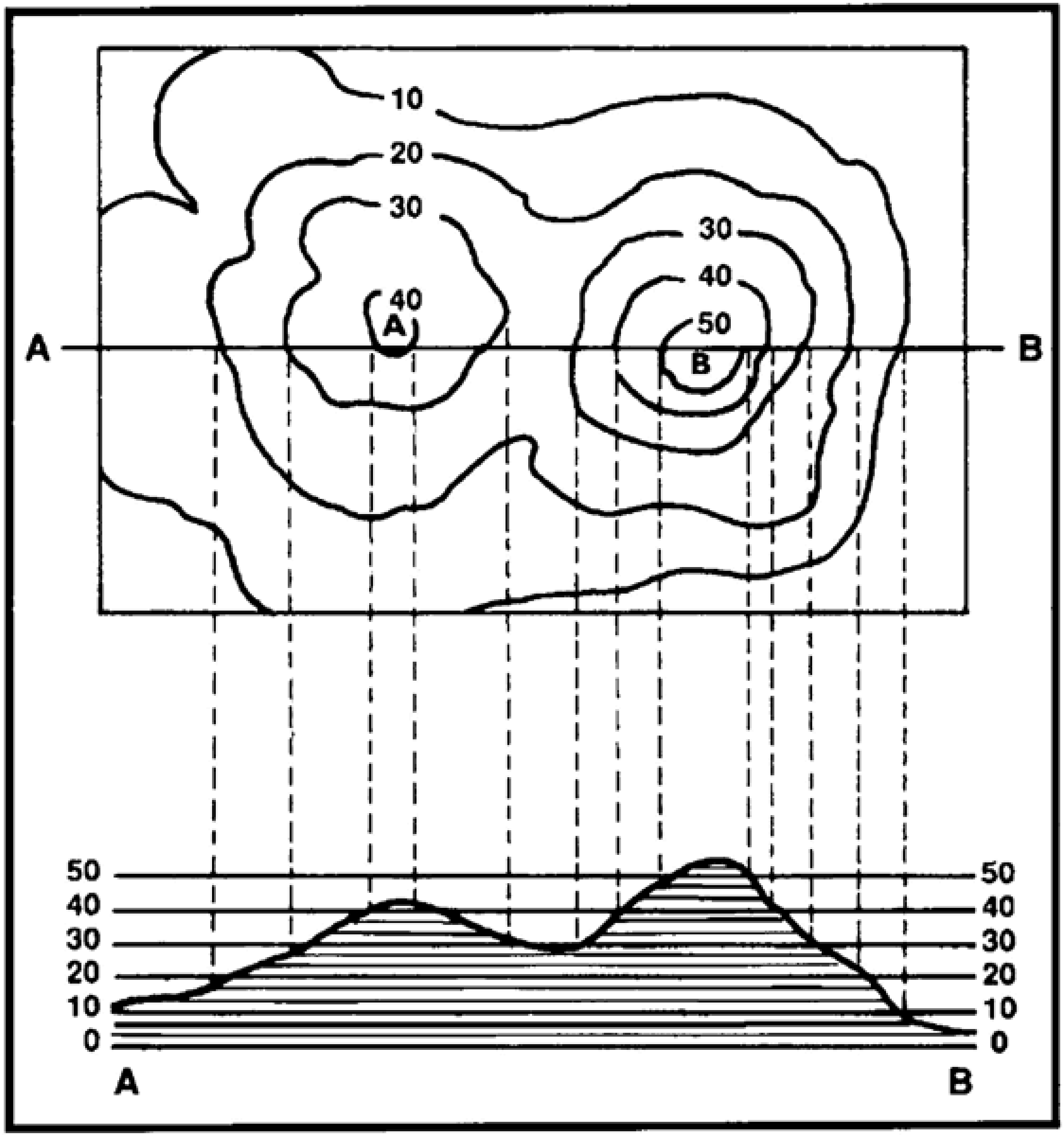
All points on the surface of a charged conductor in electrostatic equilibrium are at the same potential.

Therefore, the electric potential is a constant everywhere on the surface of a charged conductor in equilibrium.

The top of this drawing is a "contour map" of the hills drawn at the bottom. The vertical distance between contour lines is 10 feet. The countour lines are lines of equal gravitational potential.



Rivers flow downhill, so rivers on a topographic map are perpendicular to contour lines. Water will only flow from a point of higher gravitational potential to a point of lower potential.



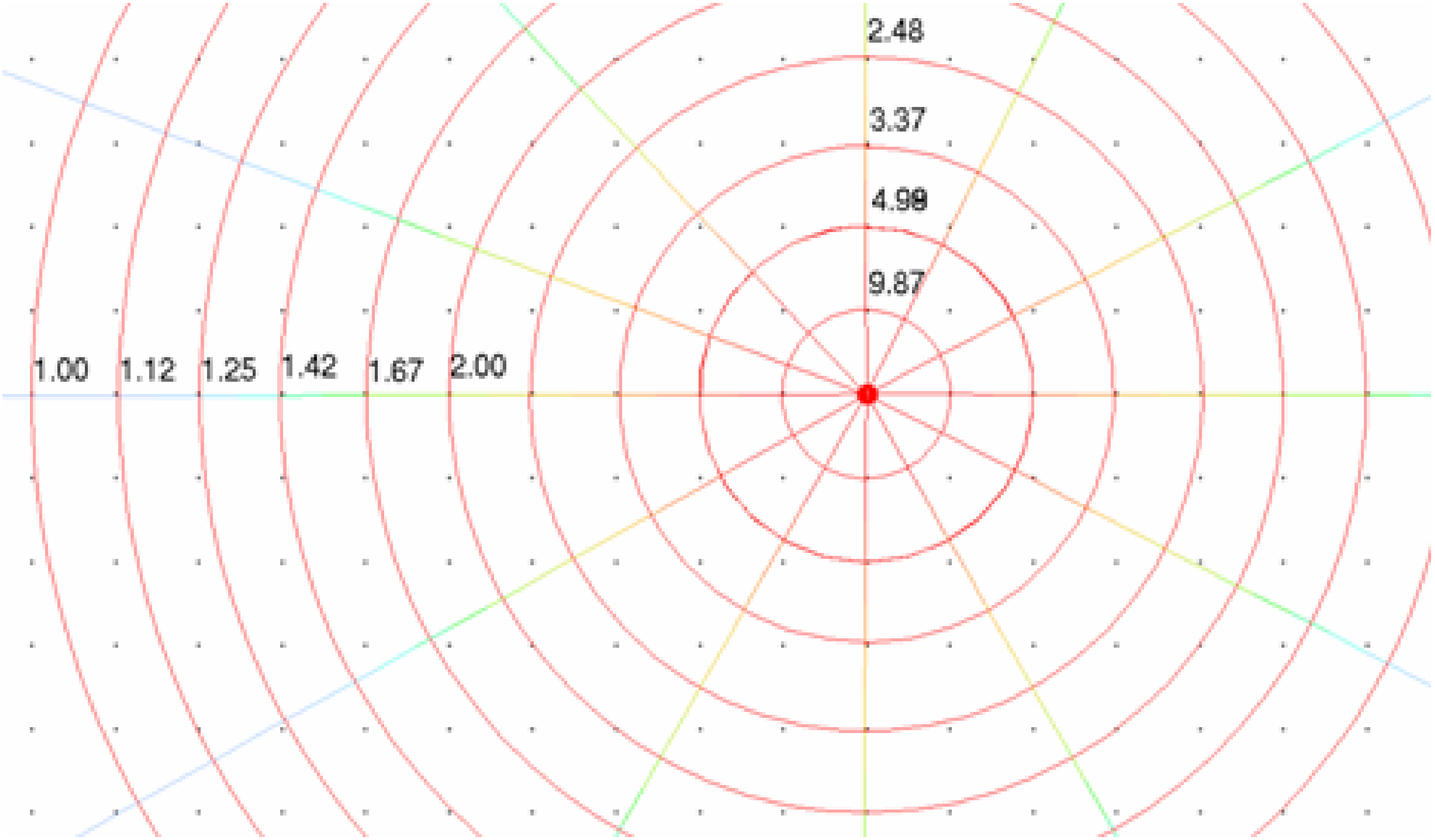
Equipotential Surfaces

An *equipotential surface* is a surface on which all points are at the same potential.

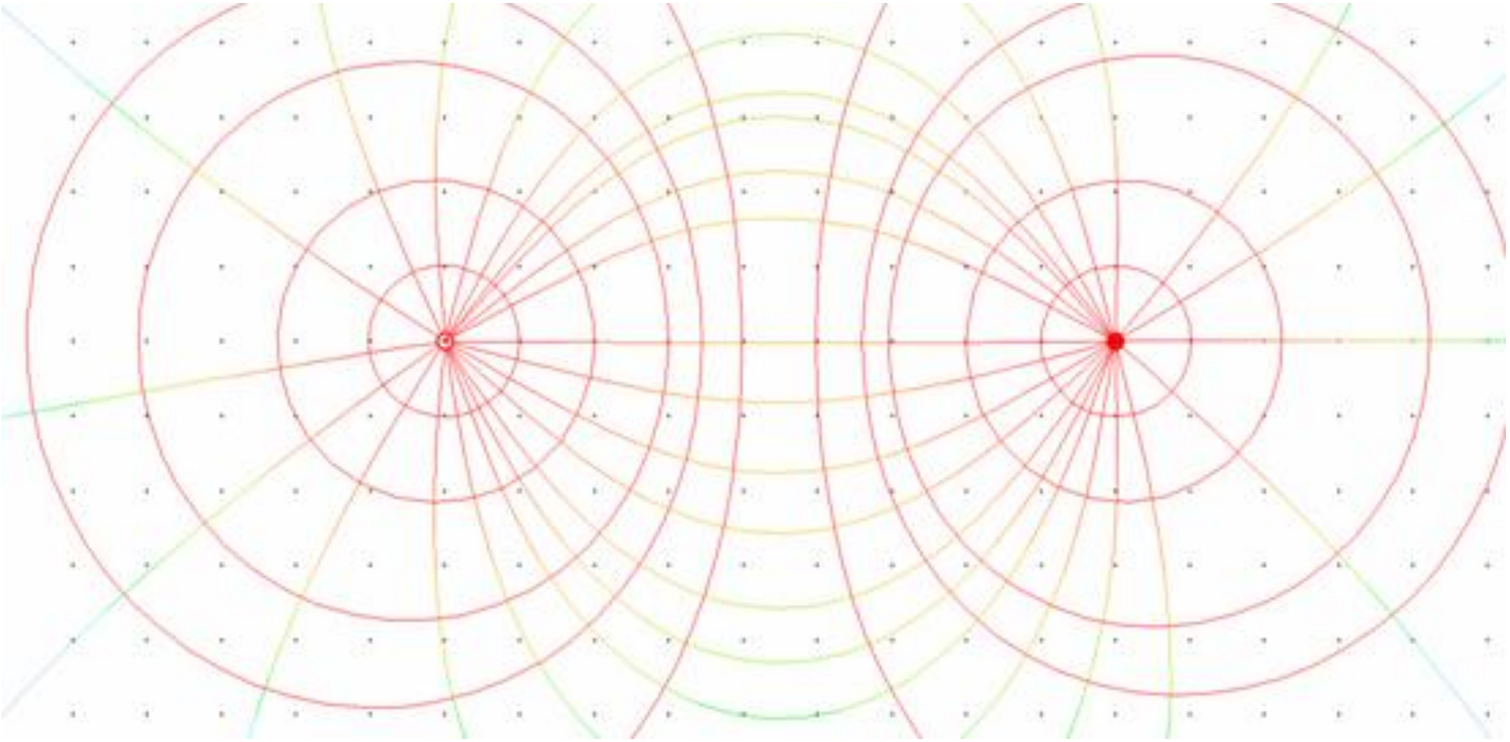
No work is required to move a charge at a constant speed on an equipotential surface.

The electric field at every point on an equipotential surface is perpendicular to the surface.

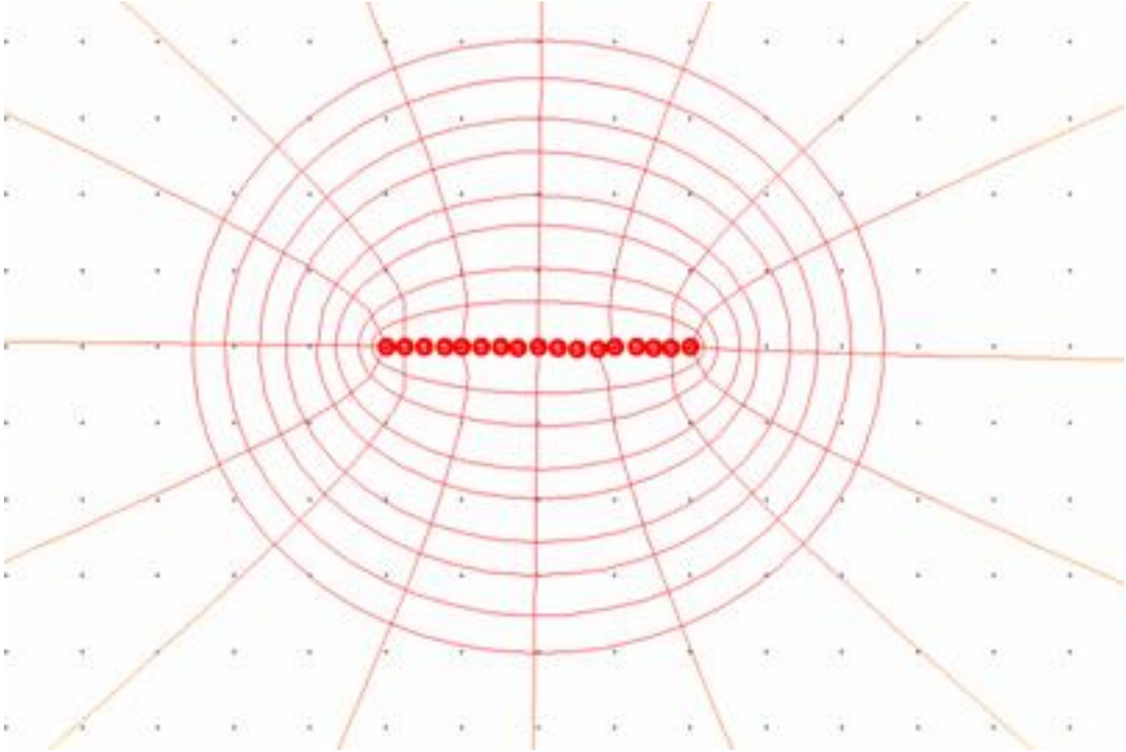
Here are some examples.



An isolated point charge. Equipotential lines are circles. Field lines radiate outward, perpendicular to equipotentials. (In 3-D, equipotentials are spherical surfaces.)

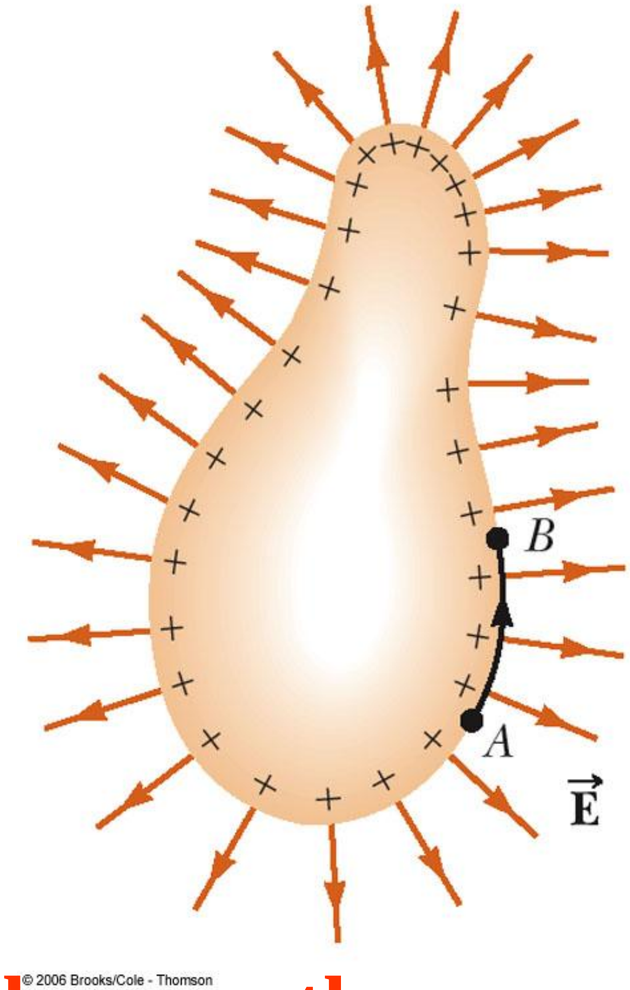


Two equal charges (+ and -). Field lines are perpendicular to equipotentials.



A line of positive charge. Field lines are perpendicular to equipotentials.

Conductors in Equilibrium



The conductor has an excess of positive charge.
All of the charge resides at the surface.
$E = 0$ inside the conductor.
The electric field just outside the conductor is perpendicular to the surface.

The potential is a constant everywhere on the surface of the conductor.
The potential everywhere inside the conductor is constant and equal to its value at the surface.