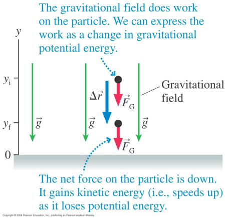
A Uniform Gravitational Field



- We could define a gravitational field in much the same way we have defined the electric field:

$$\vec{E} = \frac{\vec{F}_{on\ q}}{q}, \ \vec{g} = \frac{\vec{F}_{on\ m}}{m}$$

(note that m/s^2 = N/kg)

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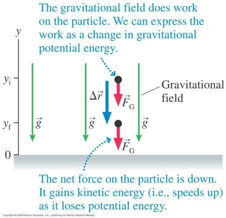

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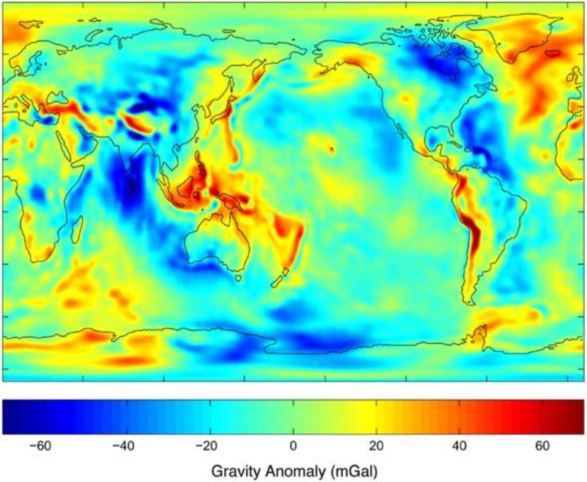
- The gravitational field near the earth is nearly uniform ($\approx$ 9.8 N/kg) much like the electric field in a capacitor.

A Uniform Gravitational Field

Small variations in $\vec{g}$ on the earth's surface are of interest.

http://www.physlink.com/news/072403GraceGravityField.cfm



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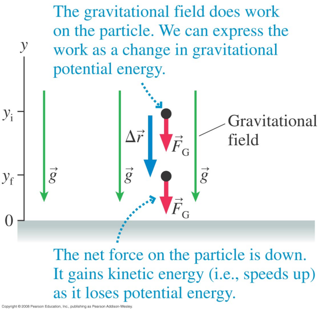

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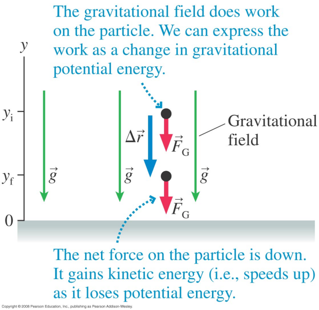

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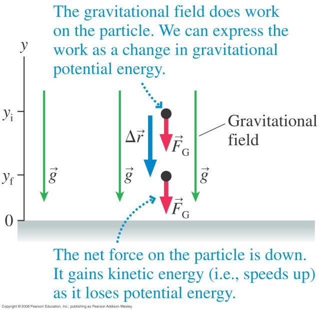

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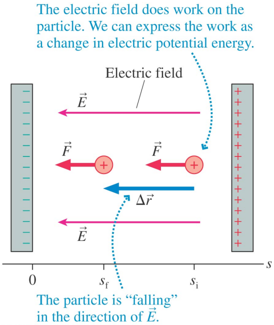
- If we define U_0 as the potential energy at $y = 0$ we get

$$U_{grav} = U_0 + mgy$$

A Uniform Electric Field



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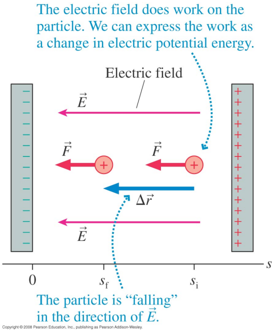

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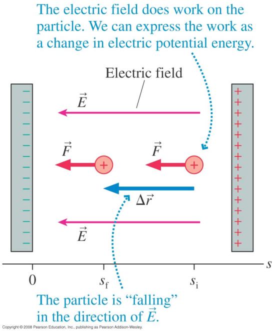

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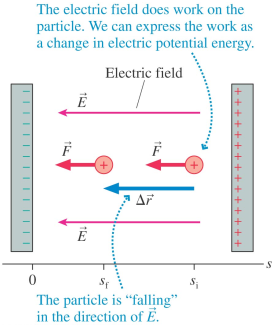

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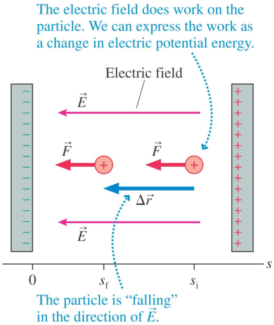

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- Again we can write:

$$U_{elec} = U_0 + qEs$$

The Potential Energy of Point Charges (29.2)

- We now come back to the force between two point charges. Again, we will use Coulomb's law. This time we are seeking potential energy for a system of two charges.

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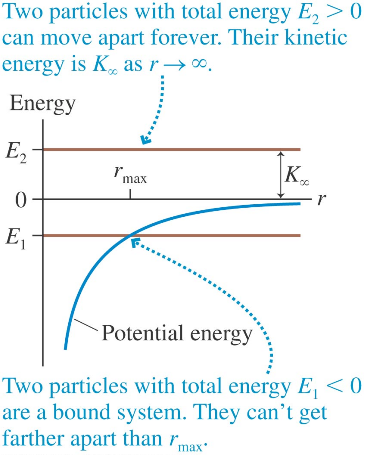
- For multiple charges just add the potentials of every pair.

The Zero of Potential Energy



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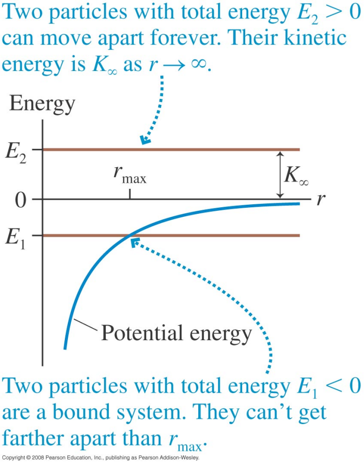

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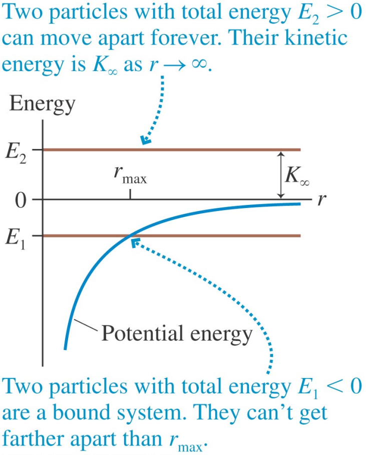

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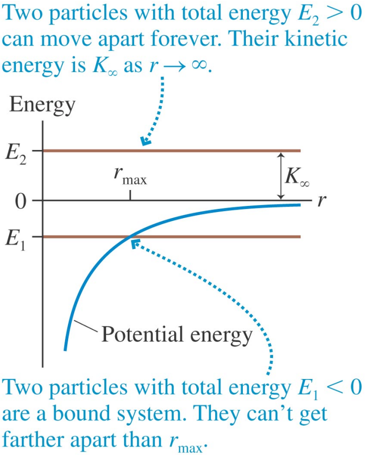

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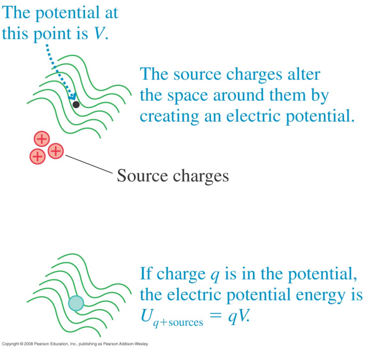
- If we define U_0 as the value at infinity then our U_{elec} is just the "amount of interaction" (ie. it is relative to zero).
- The tricky bit is that now we have negative potential energies.

The Electric Potential (29.4)



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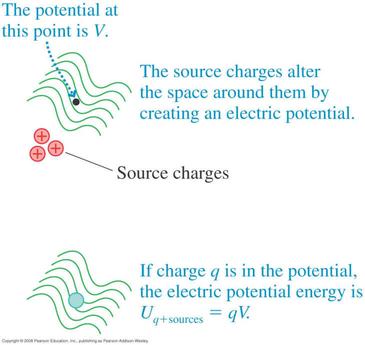

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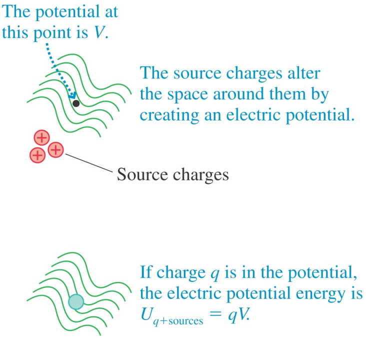

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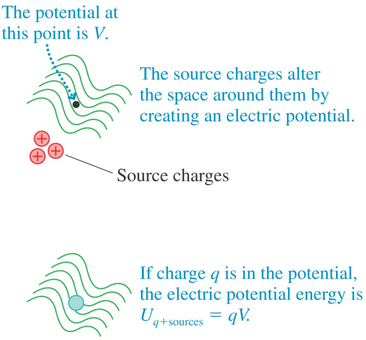

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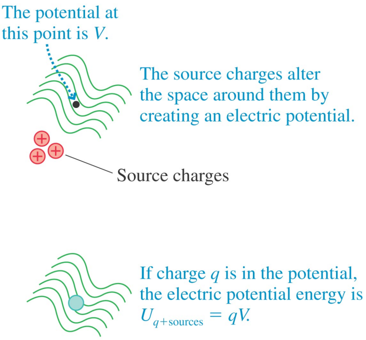

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$$\begin{aligned} \textit{force on q} &= [\textit{charge q}] \times [\textit{alteration of space by source charge}] \\ \textit{potential E} &= [\textit{charge q}] \times [\textit{potential interaction of source charge}] \end{aligned}$$

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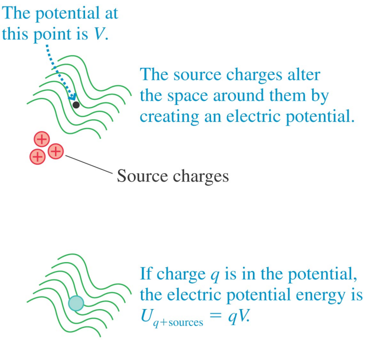

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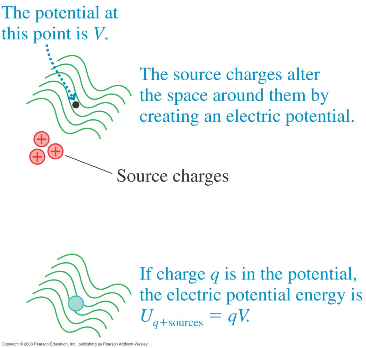

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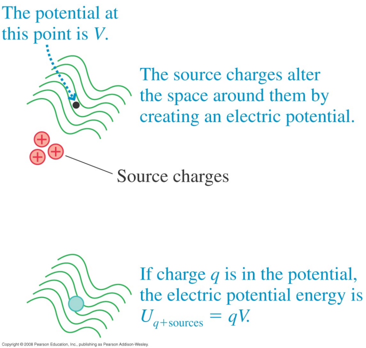

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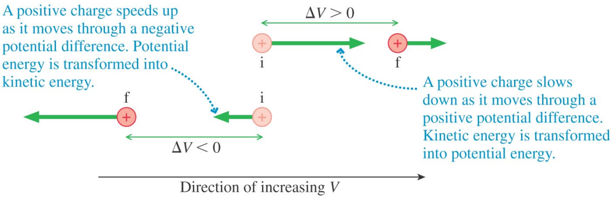
- The unit of electric potential is J/C or Volts (V).

What Good is Electric Potential?

- Electric potential depends only on source charges and their geometry.



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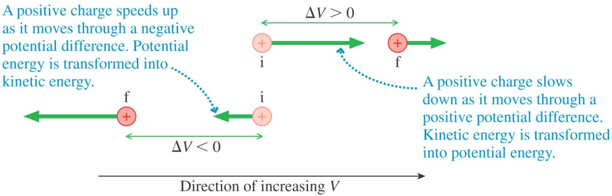

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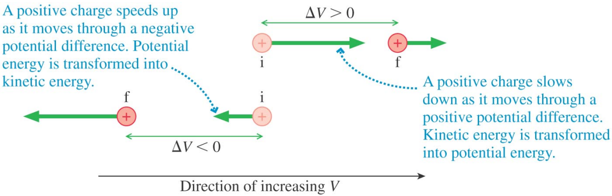

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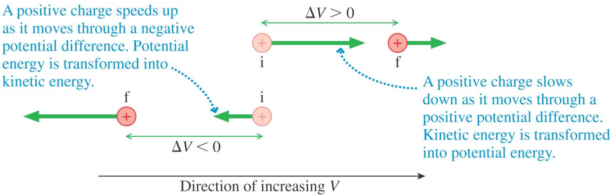
- If a charged particle moves through a potential difference ($\Delta V = V_f - V_i$) it will accelerate.



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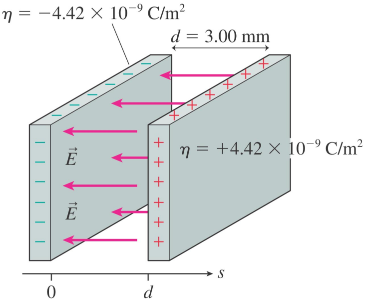
- Conservation of energy gives
$$\begin{aligned} \Delta K + q\Delta V &= 0 \\ K_f + qV_f &= K_i + qV_i \end{aligned}$$
- Conservation of energy will be a useful tool in the problems we solve in the coming weeks.

The Electric Potential Inside a Parallel Plate Capacitor (29.5)



- Electric field inside this capacitor:

$$|E| = \frac{\eta}{\epsilon_0} = 500 \text{ N/C}$$

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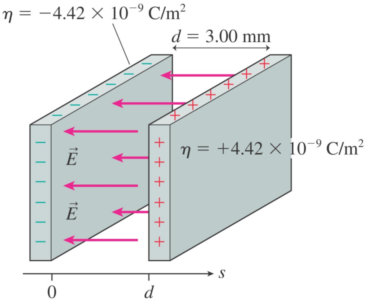

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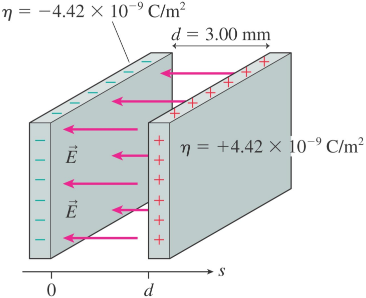

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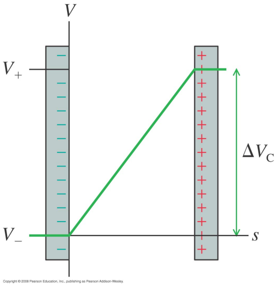
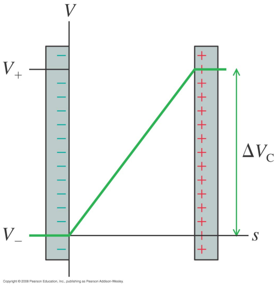
- The potential is then

$$V = \frac{U_{elec}}{q} = Es$$

The Electric Potential Inside a Parallel Plate Capacitor

- Electric potential increases linearly from the negative plate towards the positive.





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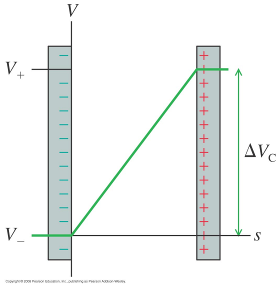

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This is the voltage across the capacitor.

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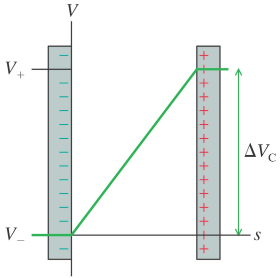

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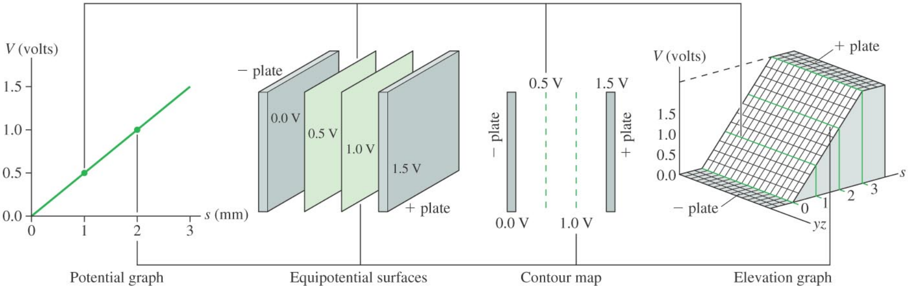
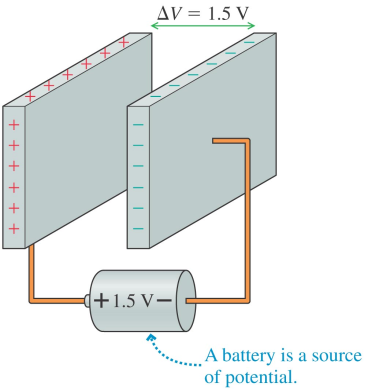
- It is useful to express the field in terms of the potential

$$E = \frac{\Delta V_C}{d}$$

Graphs, Equipotential Surfaces, Contour Maps, and Elevation Graphs





A battery is a source of potential.

The Negative Plate does not have to be Zero