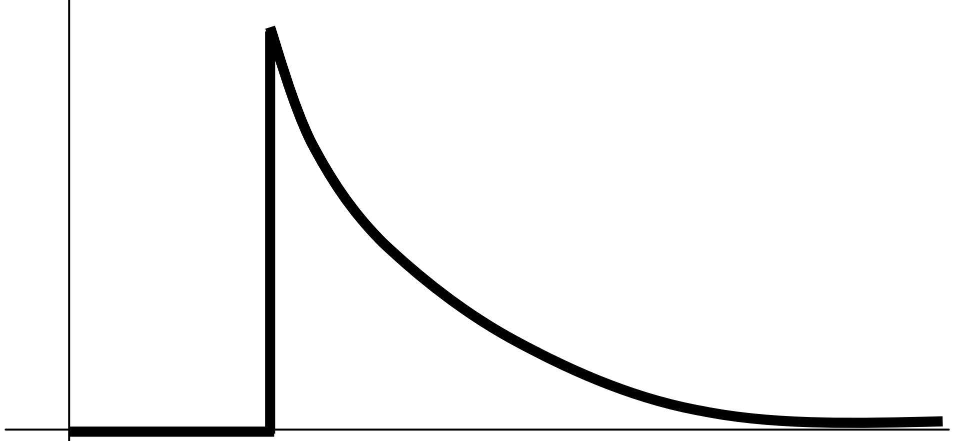
POTENTIAL



$$\mathbf{E}(\mathbf{r}) = -\nabla V(\vec{r})$$

$$V(\mathbf{r}) \equiv -\int_{\text{origin}}^{\mathbf{r}} \vec{E}(\vec{r}\,') \cdot d\vec{r}\,'$$

Could this be a plot of |E|(r)? Or V(r)?
(for SOME physical situation?)

A) Could be E(r), or V(r)

B) Could be E(r), but can't be V(r)

C) Can't be E(r), could be V(r)

D) Can't be either

E) ???

The voltage is zero at a point in space.

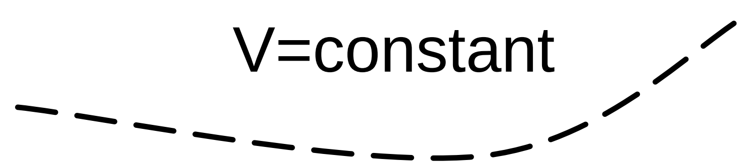
You can conclude that :

A) The E-field is zero at that point.

B) The E-field is non-zero at that point

C) You can conclude nothing at all about the E-field at that point

The voltage is constant everywhere along a line in space.



You can conclude that :

A) The E-field has constant magnitude along that line.

B) The E-field is zero along that line.

C) You can conclude nothing at all about the magnitude of **E** along that line.

We usually choose $V(r \rightarrow \infty) \equiv 0$ when calculating the potential of a point charge to be $V(r) = +\kappa q/r$. How does the potential $V(r)$ change if we choose our reference point to be $V(R)=0$ where R is closer to +q than r.

A V(r) is positive but smaller than kq/r

B V(r) is positive but larger than kq/r

C V(r) is negative

D V(r) doesn't change (V is independent of choice of reference)

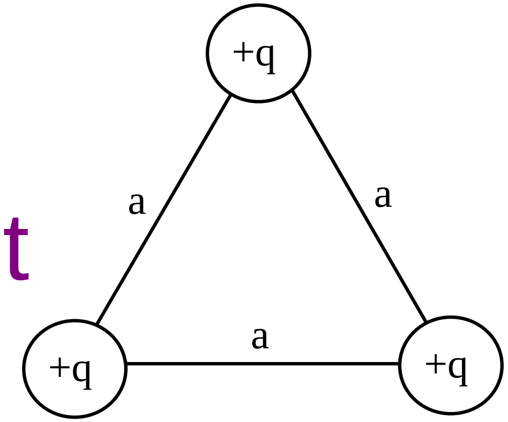
Two isolated spherical shells of charge, labeled A and B, are far apart and each has charge Q. Sphere B is bigger than sphere A. Which shell has higher voltage? [$V(r=\infty) = 0$]

A) Sphere A B) Sphere B

C) Both have same voltage.

WORK & ENERGY

Three identical charges +q sit on an equilateral triangle.



What would be the final KE of the *top* charge if you released it (keeping the other two fixed)

A) $\frac{1}{4\pi\epsilon_0}\frac{q^2}{a}$

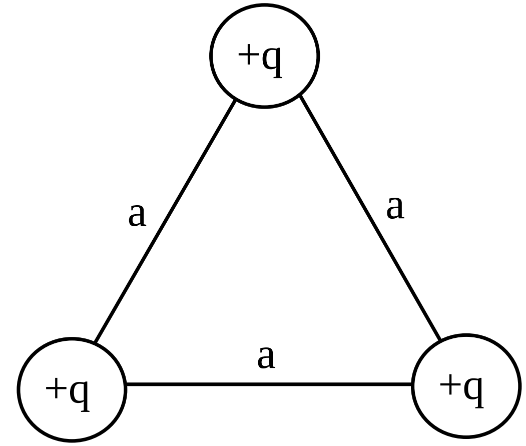
B) $\frac{1}{4\pi\epsilon_0}\frac{2q^2}{3a}$

C) $\frac{1}{4\pi\epsilon_0}\frac{2q^2}{a}$

D) $\frac{1}{4\pi\epsilon_0}\frac{3q^2}{a}$

E) other

Three identical charges +q sit on an equilateral triangle.



What would be the final KE of the *top* charge if you released *all three?*

A) $\dfrac{1}{4\pi\varepsilon_0}\dfrac{q^2}{a}$

B) $\dfrac{1}{4\pi\varepsilon_0}\dfrac{2q^2}{3a}$

C) $\dfrac{1}{4\pi\varepsilon_0}\dfrac{2q^2}{a}$

D) $\dfrac{1}{4\pi\varepsilon_0}\dfrac{3q^2}{a}$

E) other

Does system energy “superpose”?

That is, if you have one system of charges with total stored energy W1, and a second charge distribution with W2… if you superpose these charge distributions, is the total energy of the new system simply W1+W2?

A) Yes

B) No

The energy stored in a particular arrangement of charges can be expressed as:

$$W_{sys} = \tfrac{1}{2} \sum q_i \cdot V_i(\mathbf{r}_i)$$

or as: $$W_{sys} = \tfrac{1}{2} \int \mathbf{E}^2 \, d\tau'$$

Why can the first expression be negative, but the second one is positive (or zero)?

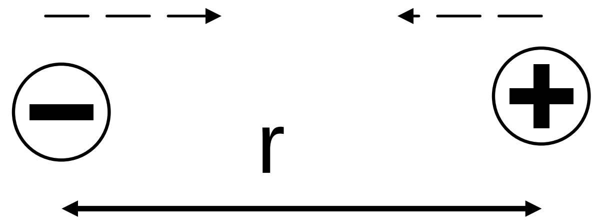
A – There must be a mistake in the derivation.

B –The second expression also contains the energy required to *make* the charges.

C – Energy is always a positive quantity, which we expressed by squaring the E-field.

D – Must be something else.

E – How should I know? I don’t do the reading assignments.



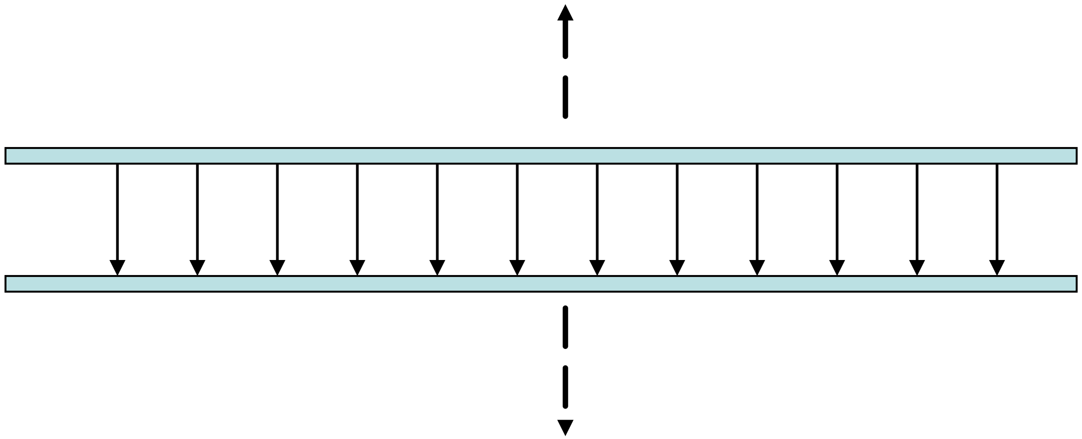
Two charges, +q and –q, are a distance r apart. As the charges are slowly moved together, the total field energy

$$\frac{\epsilon_0}{2}\int E^2 \, d\tau$$

A) increases

B) decreases

C) remains constant

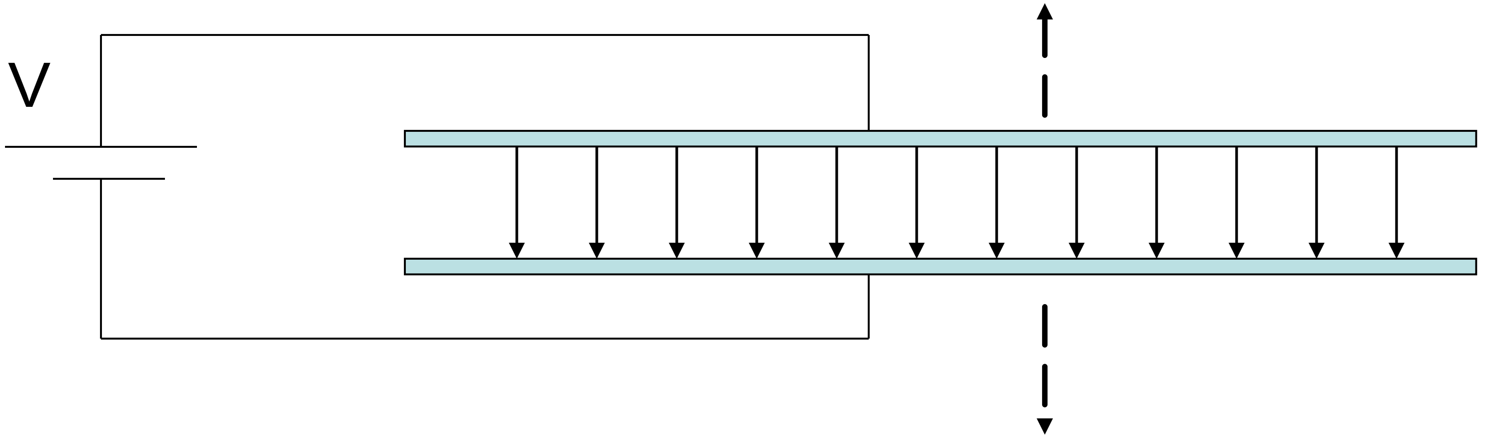


A parallel-plate capacitor has +Q on one plate, -Q on the other. The plates are isolated so the charge Q cannot change. As the plates are pulled apart, the total **electrostatic energy** stored in the capacitor

A) increases

B) decreases

C) remains constant.



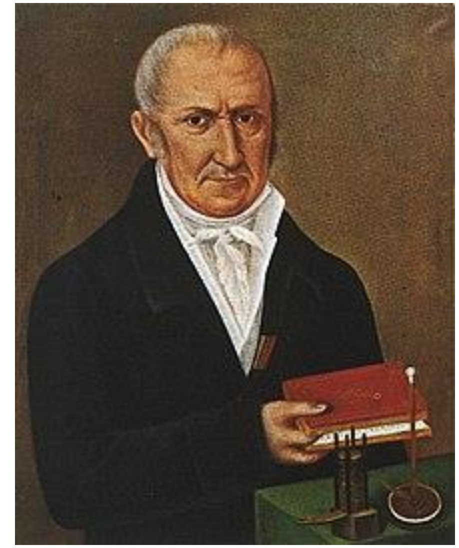
A parallel plate capacitor is attached to a battery which maintains a constant voltage difference V between the capacitor plates. While the battery is attached, the plates are pulled apart. The electrostatic energy stored in the capacitor

A) increases

B) decreases

C) stays constant.

Alessandro Volta



(18 February 1745 – 5 March 1827)
Credited as the inventor of the electric battery in 1799 and the discoverer of methane.

With this invention he proved that electricity could be generated chemically and debunked the prevalent theory that electricity was generated solely by living beings (Luigi Galvani).

Voltaic Pile of copper and zinc

The SI unit of electric potential is named in his honour as the volt.
(When people say “voltage” then really mean potential - it’s a bit like saying “meterage” for a length)