Electric forces and electric fields

Prof. Paul Doherty

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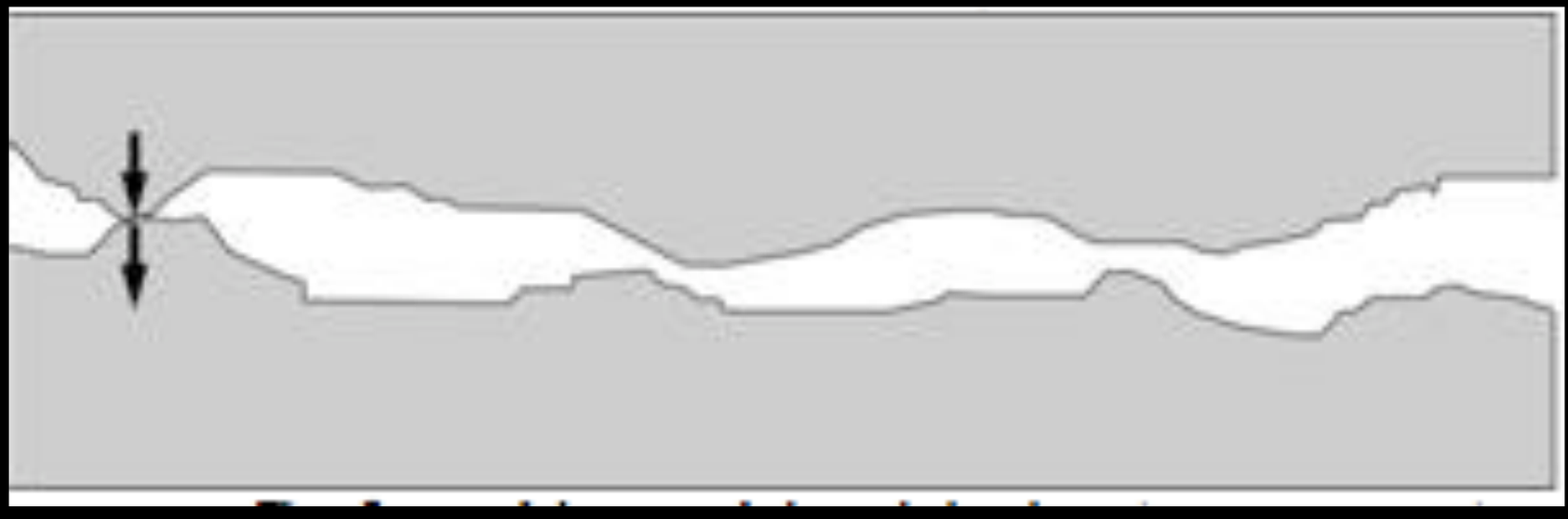
or google Paul Doherty

Experience Formication

Atomic scale view of two surfaces "touching"



Triboelectric series

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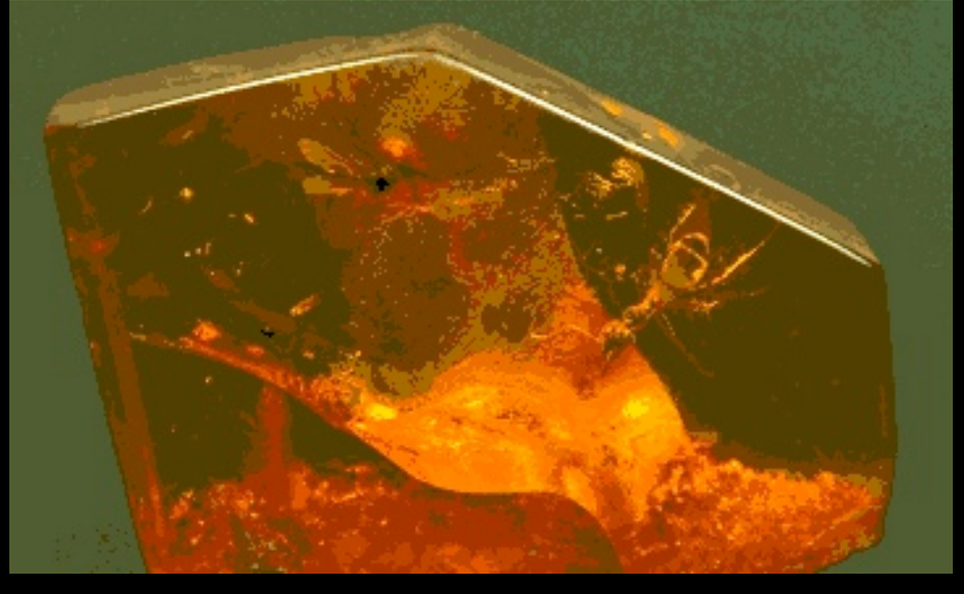

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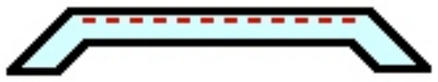
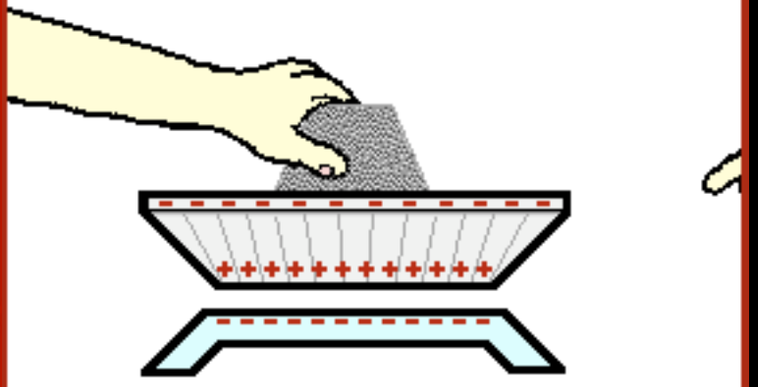
Elektron

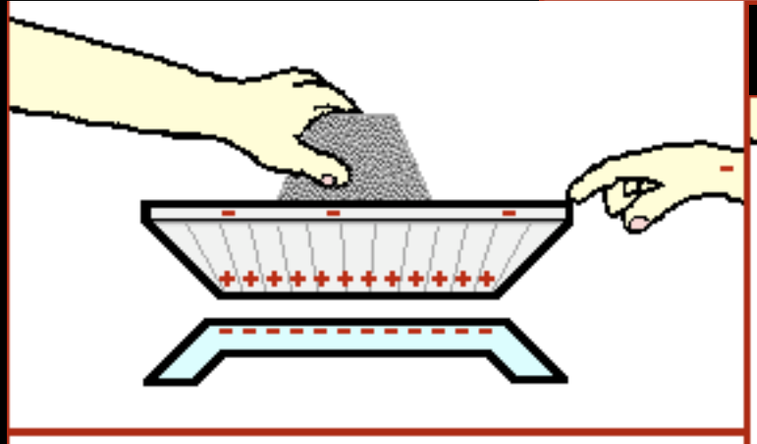
Positive
(+)
Air
Human Hands
Asbestos
Rabbit's Fur
Glass
Human Hair
Mica
Nylon
Wool
Lead
Cat's Fur
Silk
Aluminum
Paper
Cotton
Steel
Wood
Lucite
Sealing wax
Amber
Polystyrene
Polyethylene
Rubber balloon
Sulphur
Hard rubber
Nickel, Copper
Brass, Silver
Gold, Platinum
Sulfur
Acetate, Rayon
Polyester
Celluloid
Polyurethane
Polyethylene
Polypropylene
Vinyl
Silicon
Teflon
Saran Wrap
Negative
(-)



A styrofoam plate has been rubbed with wool. Since styrofoam has a greater affinity for electrons than wool, the styrofoam will become negatively-charged in the process of charging by friction.



A finger is brought near and touched to the rim of the plate (which has an excess of electrons). Once touched, electrons flow through the finger to ground. It is at this instant that the aluminum plate acquires an overall positive charge.



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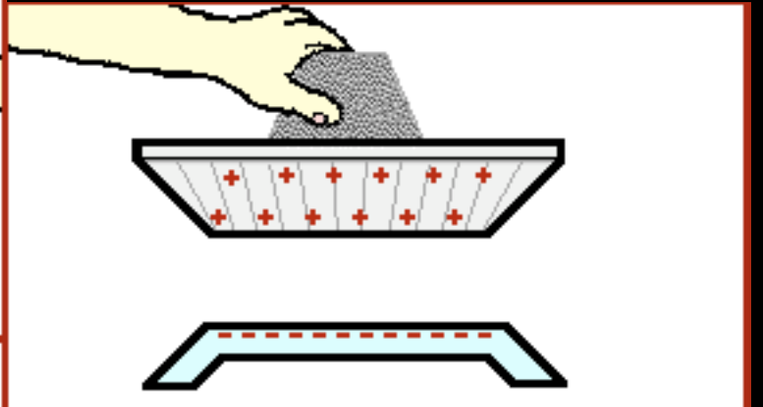
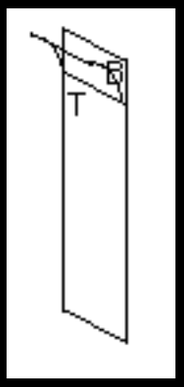


As the aluminum plate is lifted away from the styrofoam plate, there is a movement of remaining electrons within the aluminum until the excess of positive charge is uniformly distributed about the aluminum plate.


T
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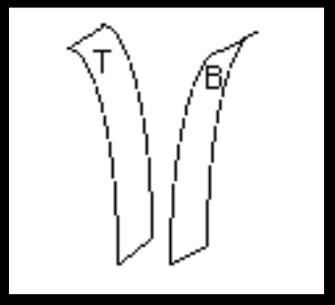
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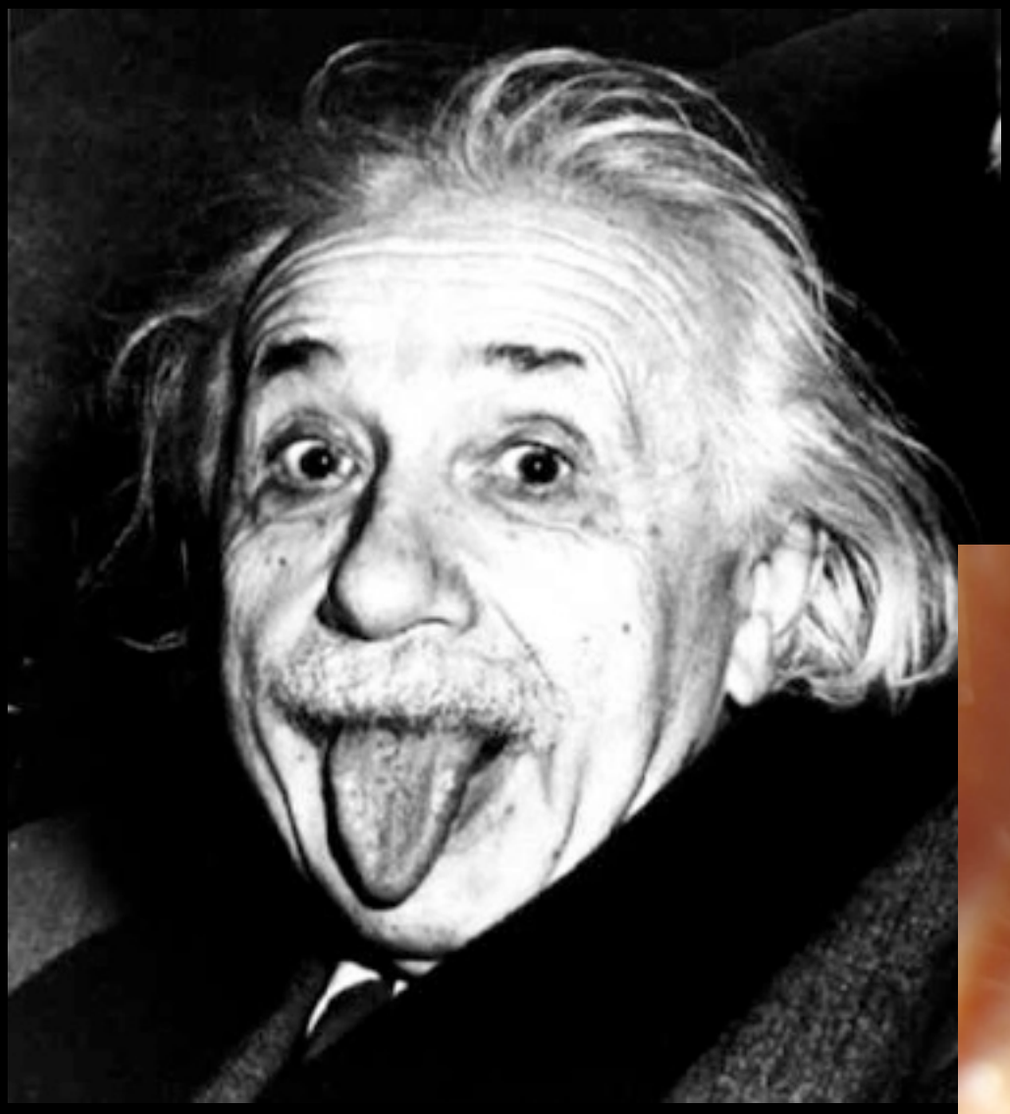
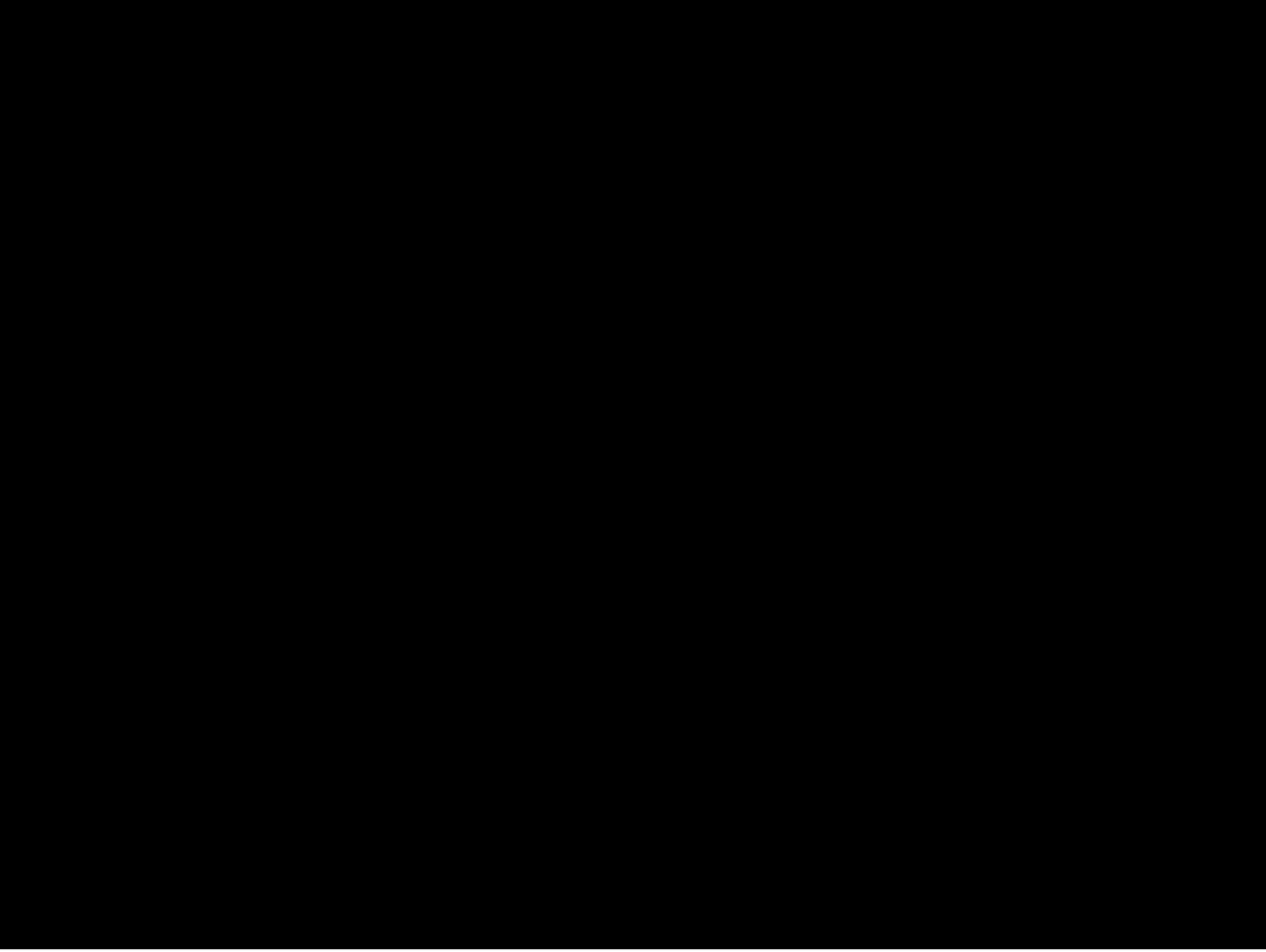




The charges involved

$mg = kq_1q_2/r^2$

$q_1q_2 = mgr^2/k$

$q_1q_2 = 10^{-4}*10*10^{-2}/10^{10}$

$q_1q_2 = 10^{-15}$

If q1 is approximately equal to q2 then $q1 = 3 * 10^{-8}$ C

about 30 nanocoulombs.

A coulomb is $6 * 10^{18}$ electron charges so this means we transferred about $1.8 * 10^{11}$ electron charges to the PVC rod and the hydra when we rubbed them.

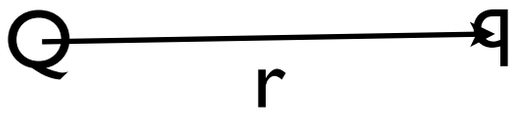
Potential Energy shows up only as differences
You can pick the potential energy at any point to be 0

For 2 point charges we choose the 0 potential energy to be at infinite distance

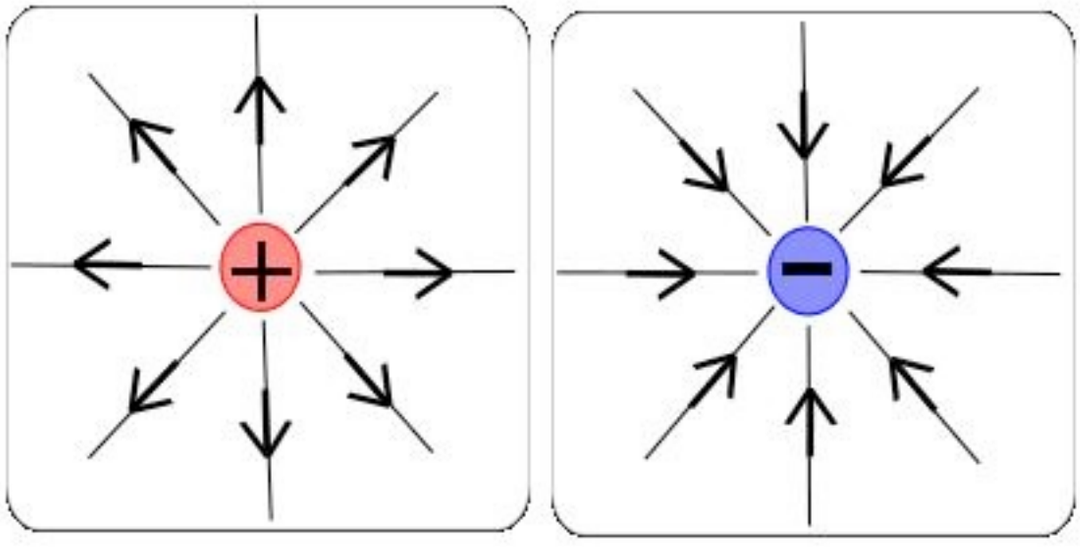
The Square of Electricity

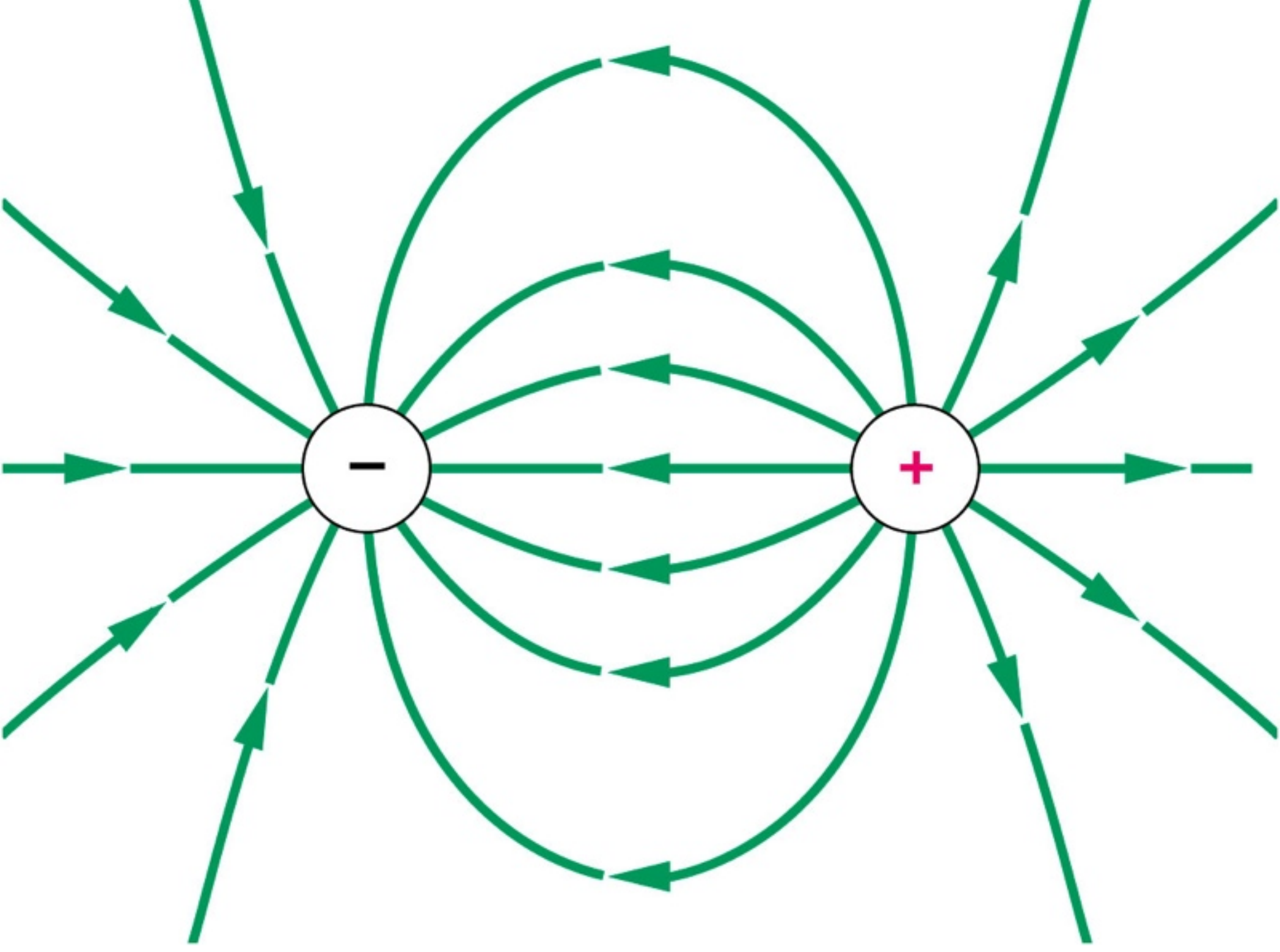
Force		Potential Energy
	Electric	
Field		Potential

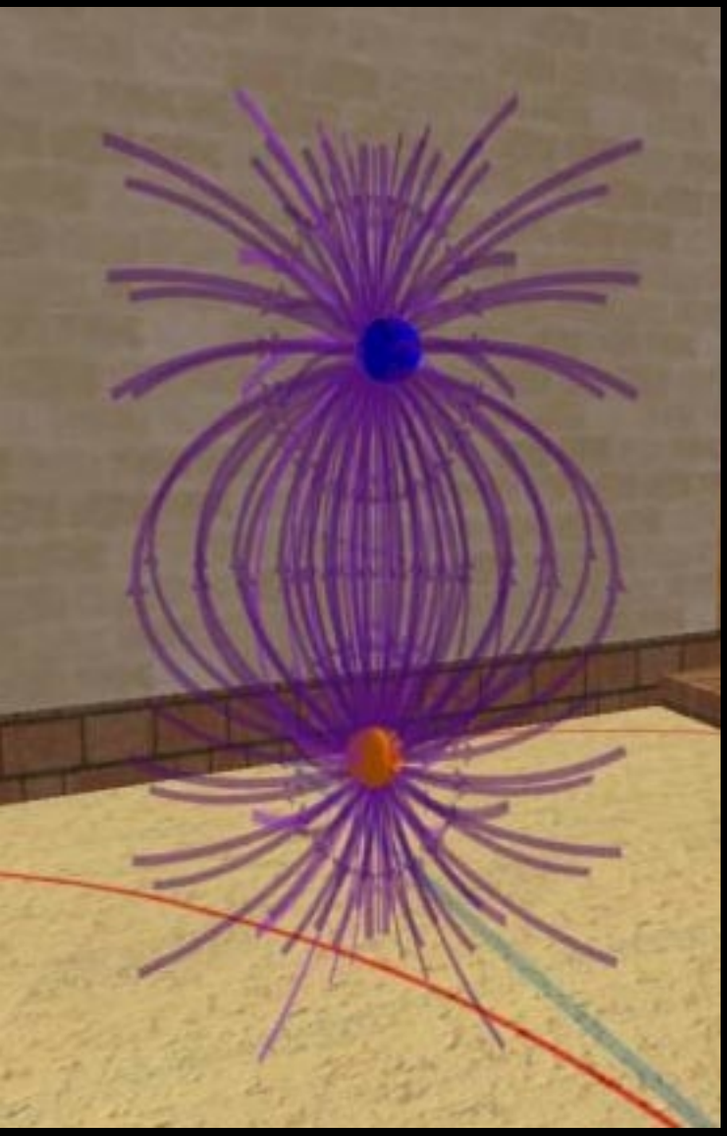
Force $F = kQq/r^2$ N		Potential Energy
$E = F/q$	Electric $k = 9 * 10^9\ Nm^2/C^2$	
Field $E = kQ/r^2$ N/C		Potential

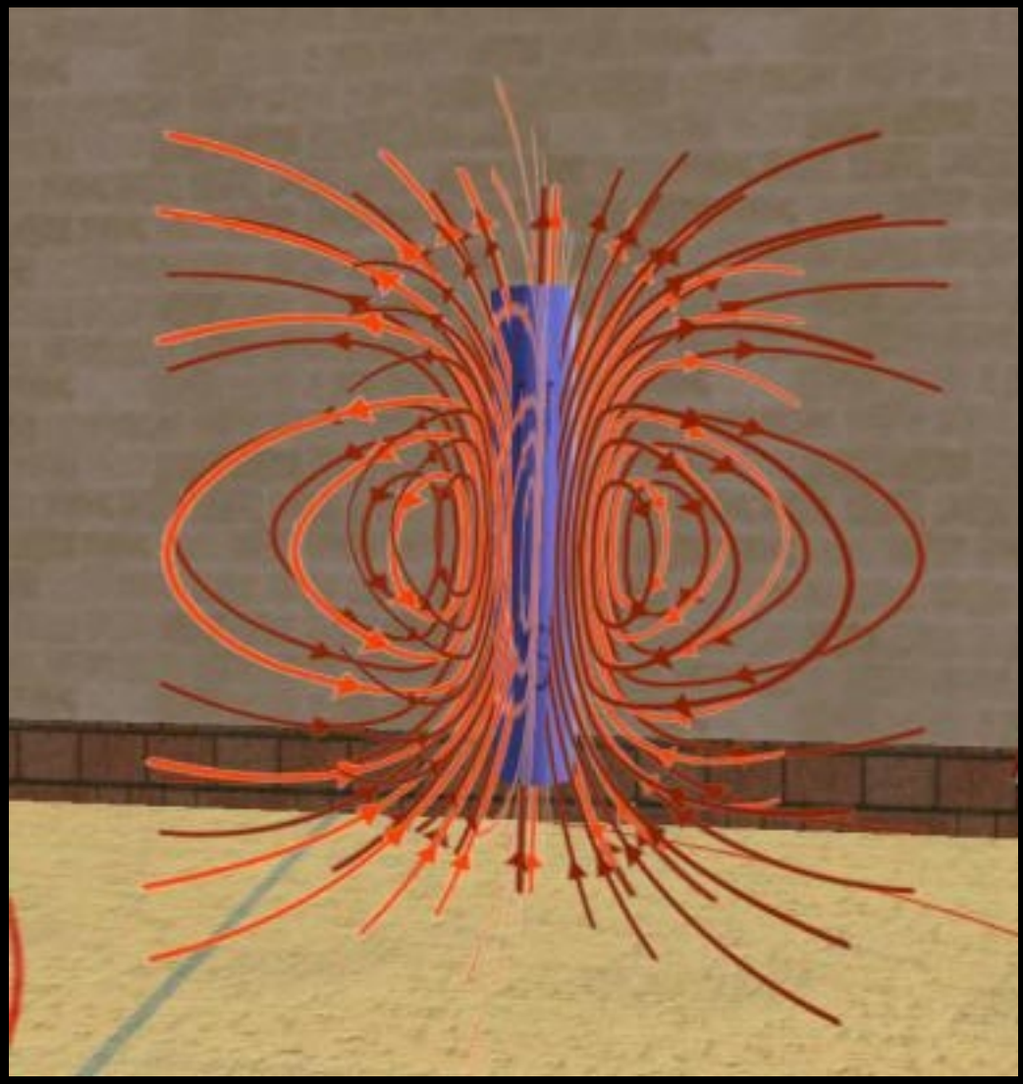


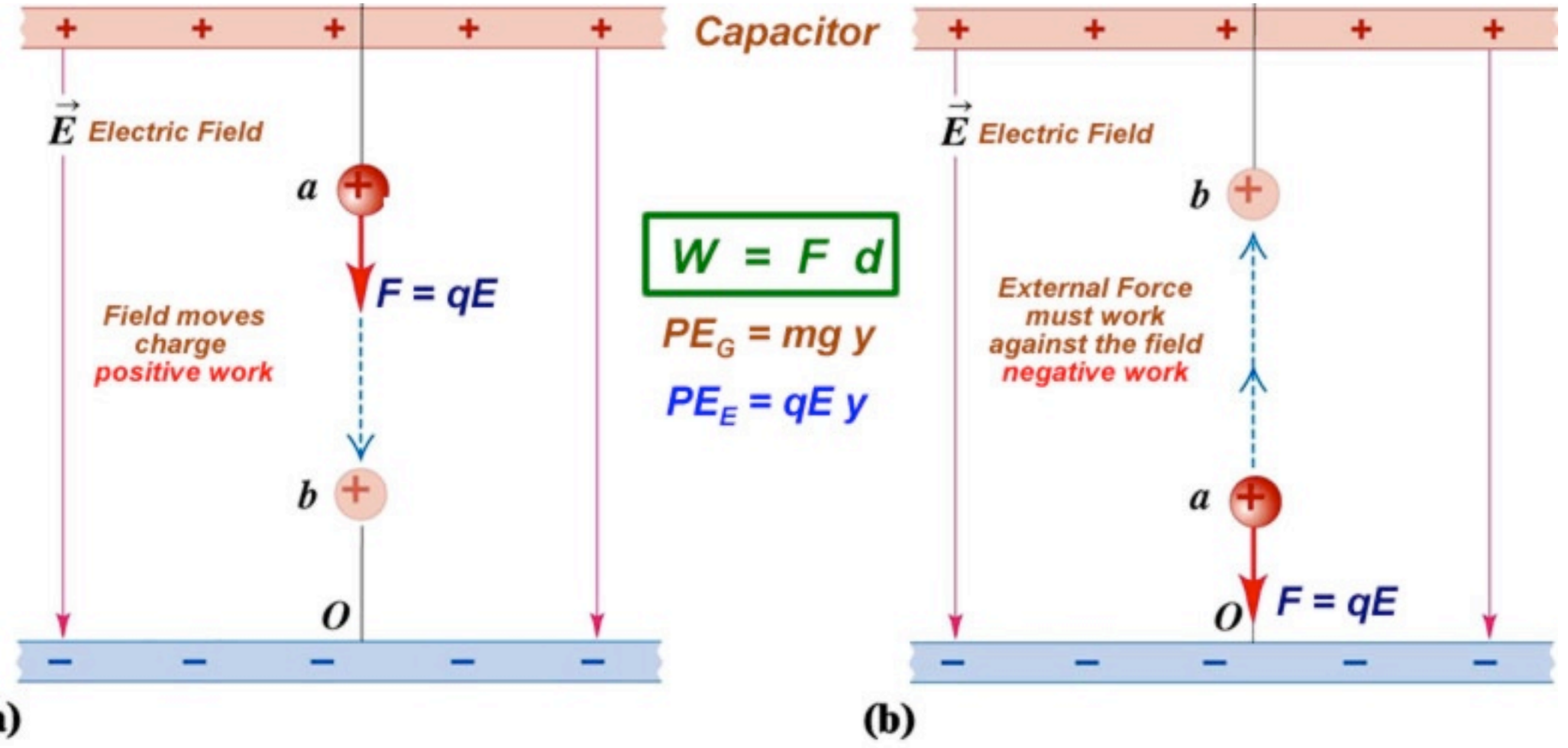
Electric Field Lines



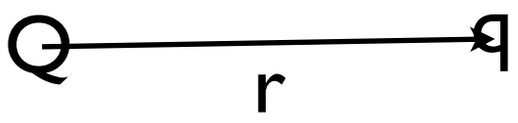







Capacitor
$\vec{E}$ Electric Field
a
F = qE
Field moves charge positive work
b
O
$W = F\ d$
$PE_G = mg\ y$
$PE_E = qE\ y$
$\vec{E}$ Electric Field
b
External Force must work against the field negative work
a
O
F = qE
(b)

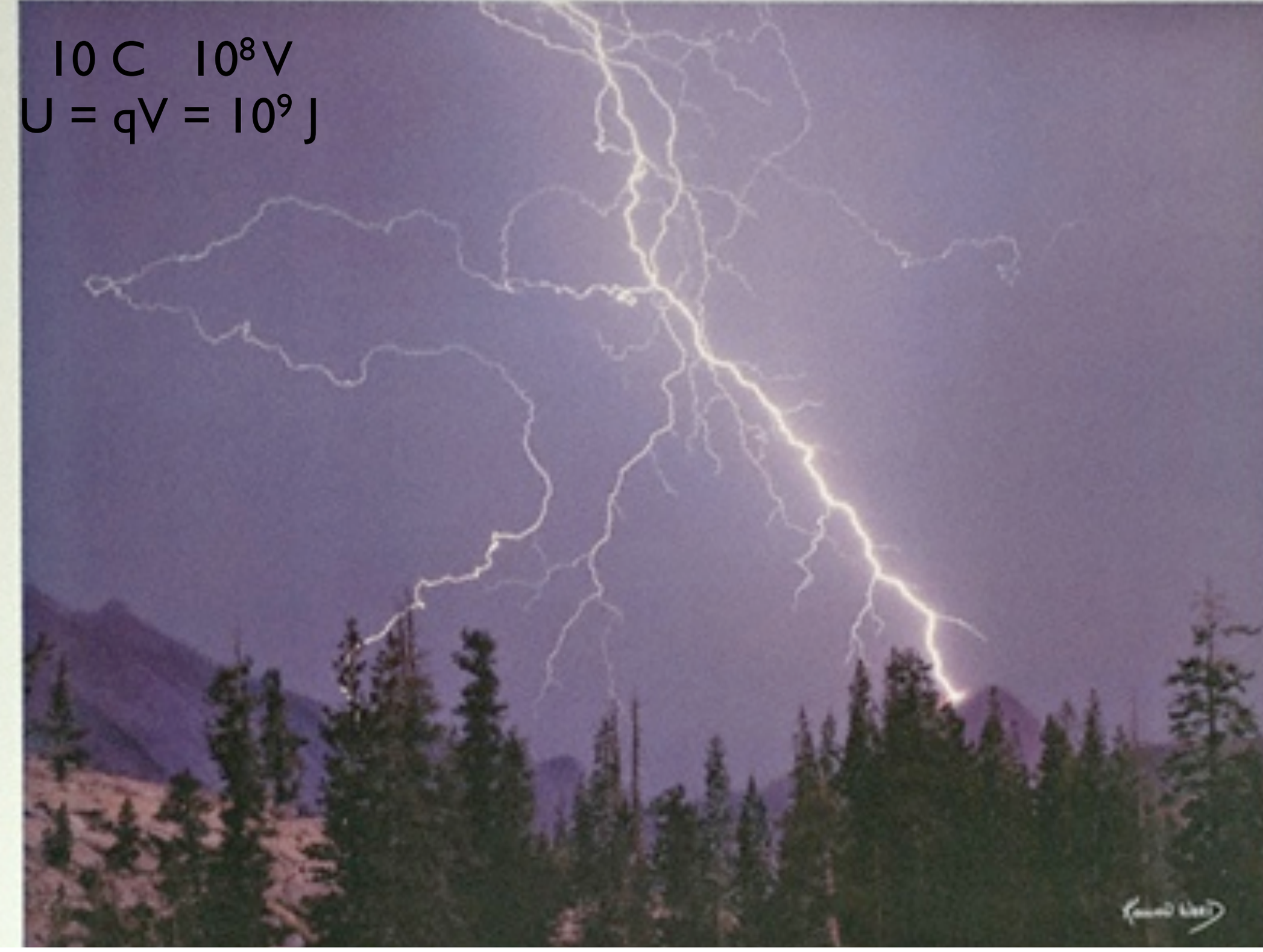
Force $F = kQq/r^2$ N	$F = -dU/dr$	Potential Energy $U = kQq/r$ J
$E = F/q$ or $F = qE$	**Electric** $k = 9 * 10^9\ Nm^2/C^2$	$V = U/q$ or $U = qV$
Field $E = kQ/r^2$ N/C or V/m	$E = -dU/dr$	Potential $V = kQ/r$ J/C or V



1 electron volt

$$qV = 1.6 * 10^{-19}\,C * 1V = 1.6 * 10^{-19}\,J$$

Ionization energy for hydrogen
Ground State 13.6 eV


10 C 10^8 V
U = qV = 10^9 J

Artificial Lightning strikes a car and arcs to the ground through the air next to a tire

Boston Museum of Science
Van der Graaf generator

http://www.youtube.com/watch?v=LLPKxk7ym7g