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# good for?

**Store Energy**

**That can be quickly released**

# Energy stored in a Capacitor

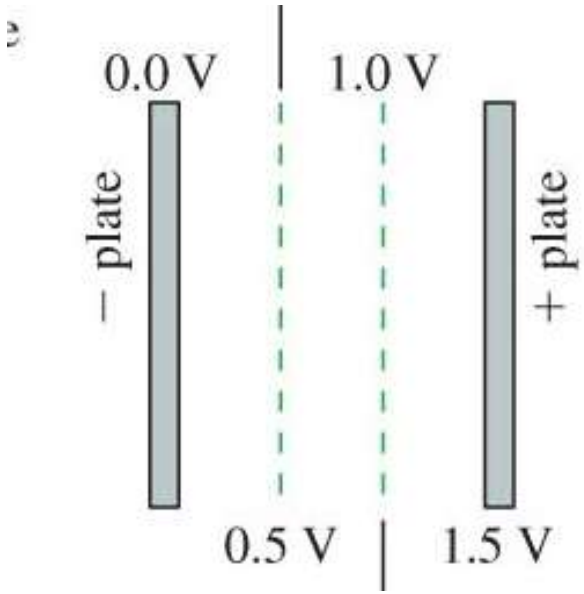
$U_C = Q\Delta V_{\text{average}}$

What would $V_{\text{average}}$ be?

$\Delta V_{\text{average}}$ *is* $0 + \Delta V = \frac{1}{2}\,\Delta V$

$U_C = \frac{1}{2}\,Q\Delta V_C$

$\boldsymbol{Q = C\,\Delta V_C}$



# Energy stored in a Capacitor

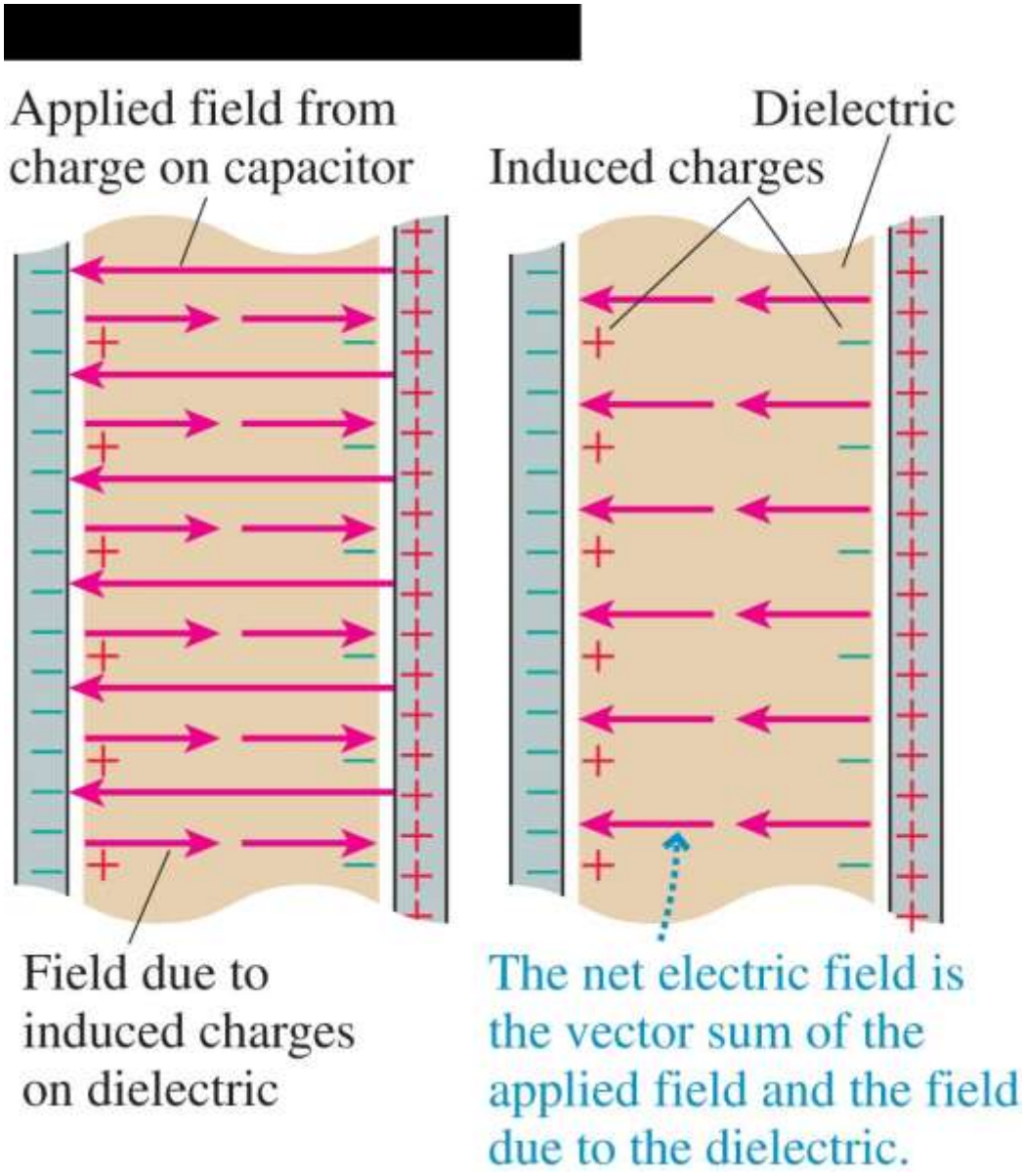
$U_C = ½\ Q\Delta V_C$

Plug in $\boldsymbol{Q = C\,\Delta V_C}$

$U_C = ½\ C(\Delta V_C)2$

$$U_C = ½\ Q\Delta V_C = ½\ C(\Delta V_C)2 = ½\ Q^2/C$$

# Dielectrics and Capacitors

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# Dielectric Constant

With a dielectric between its plates, the capacitance of a parallel-plate capacitor is increased by a factor of the *dielectric constant* κ:

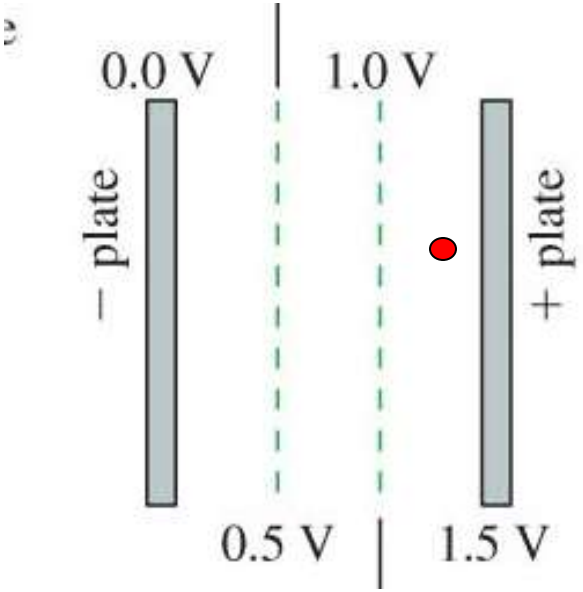
| Material | Dielectric constant $\kappa$ |
|---|---|
| Vacuum | 1 (exactly) |
| Air | 1.00054* |
| Teflon | 2.0 |
| Paper | 3.0 |
| Pyrex glass | 4.8 |
| Cell membrane | 9.0 |
| Ethanol | 24 |
| Water | 80 |
| Strontium titanate | 300 |

*Use 1.00 in all calculations.

$$C = \frac{\kappa \epsilon_0 A}{d}$$

Capacitance of a parallel-plate capacitor with a dielectric of dielectric constant $\kappa$

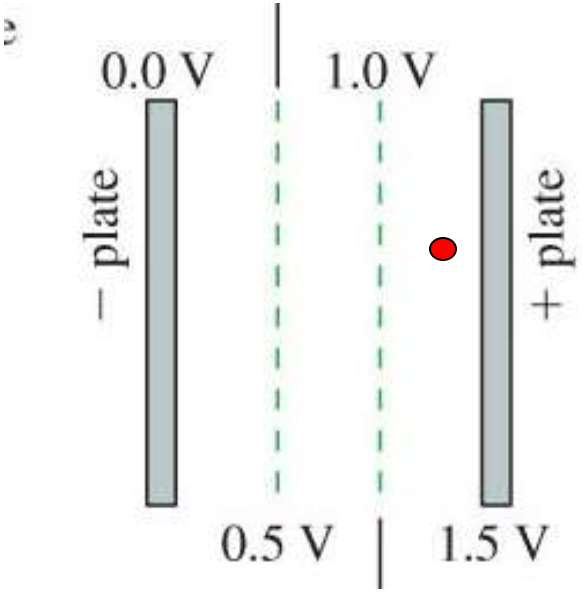
# Problem




Let's say a 5 μF capacitor has a potential difference of 1.5 V with a spacing of 1.0 mm. A proton placed 0.20 mm from the positive plate?

Calculate everything that you can about this capacitor and the proton.

# Problem




Let's say a 5 μF capacitor has a potential difference of 1.5 V with a spacing of 1.0 mm. What is the electric field between the plates?

**Which approach will help you?**

A. Find charge of the capacitor, then use $E = kq/r^2$
B. Use one of the potential energy equations for capacitors
C. Find the force, $F = kqq/r^2$, then use $F = qE$
D. $\Delta V = - E\Delta x$
E. $C = \varepsilon_o A/d$

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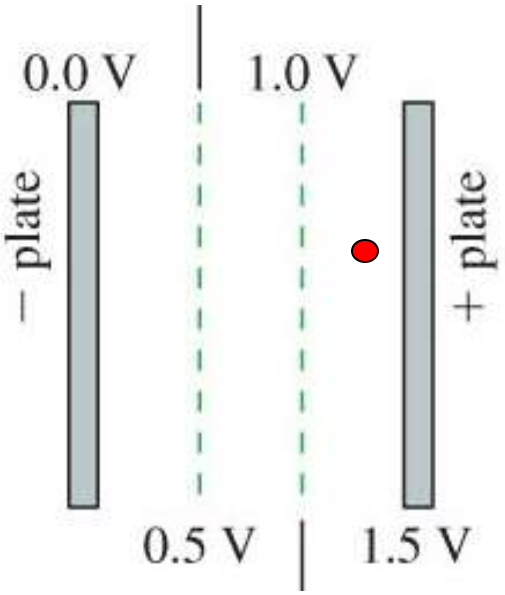


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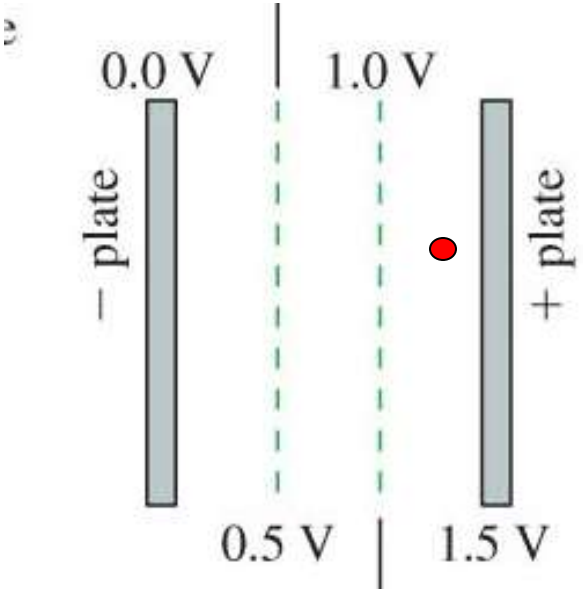
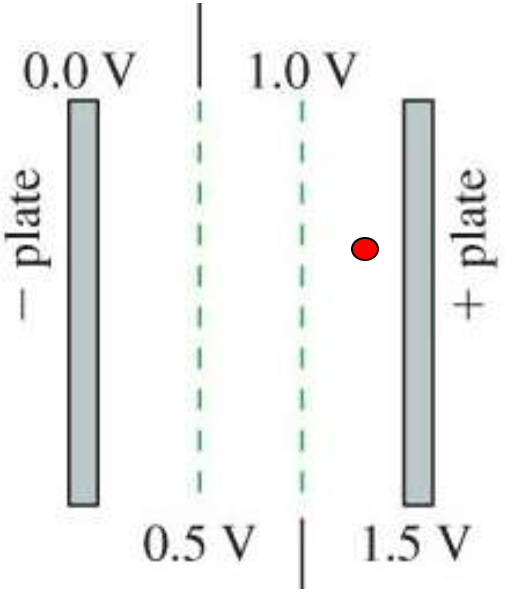



$$\Delta V = - E \Delta x$$

$$E = \Delta V / d =$$

# Problem

Let's say a 5 μF capacitor has a potential difference of 1.5 V with a spacing of 1.0 mm. What is the acceleration of a proton placed 0.20 mm from the positive plate?




**Which approach will help you?**

A. Find charge of the capacitor, then use $F = kqq/r^2$ then then $F = ma$
B. Find the electric field, then use $F = qE$ and $F = ma$.
C. Use one of the potential energy equations for capacitors and set it equal to work and then $F = ma$.

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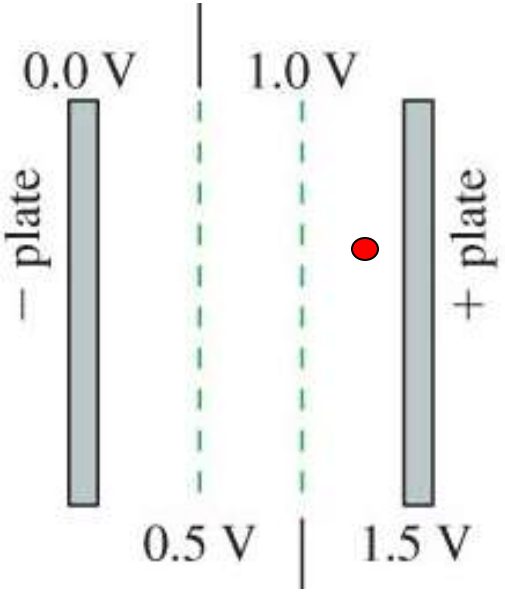


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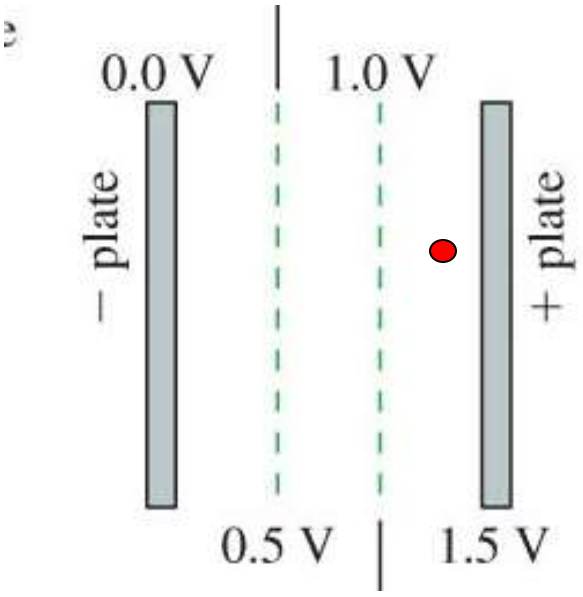


**A. Find the electric field, then use $F = qE$ and $F = ma$.**

$\boldsymbol{F = qE} = 1.6 \text{ x } 10^{-19} \text{ C } 1500 \text{ V/m} =$

now

$F = ma$ or $a = F/m =$

$= \mathbf{1.44 \text{ x } 10^{11} \text{ m/s}^2}$

Oops!! – probably not: )