A capacitor consists of two conductors carrying charges of equal magnitude and opposite sign. The capacitance \( C \) of any capacitor is the ratio of the charge \( Q \) on either conductor to the potential difference \( \Delta V \) between them:

\[
C = \frac{Q}{\Delta V}
\]  
(26.1)

The capacitance depends only on the geometry of the conductors and not on an external source of charge or potential difference. The SI unit of capacitance is coulombs per volt, or the farad (F): 1 F = 1 C/V.

**Definitions**

**Concepts and Principles**

If two or more capacitors are connected in parallel, the potential difference is the same across all capacitors. The equivalent capacitance of a parallel combination of capacitors is

\[
C_{eq} = C_1 + C_2 + C_3 + \cdots
\]  
(26.8)

If two or more capacitors are connected in series, the charge is the same on all capacitors, and the equivalent capacitance of the series combination is given by

\[
\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \cdots
\]  
(26.10)

These two equations enable you to simplify many electric circuits by replacing multiple capacitors with a single equivalent capacitance.

When a dielectric material is inserted between the plates of a capacitor, the capacitance increases by a dimensionless factor \( \kappa \), called the dielectric constant:

\[
C = \kappa C_0
\]  
(26.14)

where \( C_0 \) is the capacitance in the absence of the dielectric.

The electric dipole moment \( \vec{p} \) of an electric dipole has a magnitude

\[
\vec{p} = 2aq
\]  
(26.16)

where \( 2a \) is the distance between the charges \( q \) and \( -q \). The direction of the electric dipole moment vector is from the negative charge toward the positive charge.

Energy is stored in a charged capacitor because the charging process is equivalent to the transfer of charges from one conductor at a lower electric potential to another conductor at a higher potential. The energy stored in a capacitor of capacitance \( C \) with charge \( Q \) and potential difference \( \Delta V \) is

\[
U_k = \frac{Q^2}{2C} = \frac{1}{2} Q \Delta V = \frac{1}{2} C (\Delta V)^2
\]  
(26.11)

\[
\mu_E = \frac{\varepsilon_0}{2} E^2
\]

The torque acting on an electric dipole in a uniform electric field \( \vec{E} \) is

\[
\vec{\tau} = \vec{r} \times \vec{p}
\]  
(26.18)

The potential energy of the system of an electric dipole in a uniform external electric field \( \vec{E} \) is

\[
U_E = -\vec{p} \cdot \vec{E}
\]  
(26.20)