Lecture 10

Chapter 26

Capacitance

Capacitance (16)

- Checkpoint #2 – For capacitors charged by same battery, does q stored by capacitor increase, decrease or remain same? When a) Plate separation of parallel-plate capacitor is increased, b) Radius of inner cylinder of a cylindrical capacitor is increased and c) Radius of outer shell of spherical capacitor is increased
- All capacitors have same potential V from battery and so q increases (decreases) with C

$$q = CV$$

Capacitance (17)

- a) Plate separation of parallel-plate capacitor is increased,
  - C decreases so q decreases

$$C = \frac{\varepsilon_0 A}{d}$$

- b) Radius of inner cylinder of a cylindrical capacitor is increased
  - C increases so q increases

$$C = 2\pi\varepsilon_0 \frac{L}{\ln(b/a)}$$

- c) Radius of outer shell of spherical capacitor is increased
  - C decreases so q decreases

$$C = 4\pi\varepsilon_0 \frac{ab}{b-a}$$

Capacitance (18)

- What is the potential energy, *U*, of a charged capacitor?
- Think of *U* as being stored in *E* field between plates
- Calculate *W* required to charge plates to potential *V*

$$\Delta U = -W = \Delta V q$$

- Recover energy by discharging capacitor

Capacitance (19)

- Charge capacitor by transferring electrons with a battery

- More charge moved, *E* field between plates gets bigger, harder to move charges so takes positive work to charge capacitor

Capacitance (20)

- At given instance potential across plates is

$$V' = \frac{q'}{C}$$

- Transfer increment of charge dq´, work required is

$$W = \Delta V q$$

$$dW = V' dq' = \frac{q'}{C} dq'$$

Capacitance (21)

- Work required from 0 to total charge q is

$$W = \frac{1}{C}\int_0^q q' dq' = \frac{q^2}{2C}$$

- Potential energy = work

$$U = \frac{q^2}{2C}$$

- Or, use

$$q = CV$$

$$U = \frac{1}{2}CV^2$$

Capacitance (22)

- Advantage of capacitor
  - Get more power than from just a battery

$$U = \frac{1}{2} C V^2$$

  - Slowly charge capacitor with battery and then discharge quickly
  - Examples – photo flash, medical defibrillator