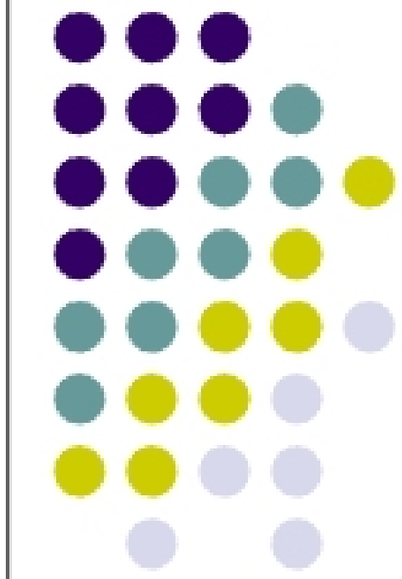
# Chapter 28

## Direct Current Circuits

1. R connections in series and in parallel
2. Define DC (direct current), AC (alternating current)
3. Model of a battery
4. Circuits with 2+ batteries – Kirchhoff's Rules
5. RC circuit



# 子曰:"温故而知新"

**Confucius says, reviewing helps one learn new knowledge.**

## Concepts:

Charge: positive, negative, conserve, induction.

Electric:
- potential $-\Delta V = \int_A^B \vec{\mathbf{E}} \cdot d\vec{\mathbf{s}}$ $\vec{\mathbf{E}} = -\nabla V \equiv (\frac{\partial}{\partial x}\mathbf{i} + \frac{\partial}{\partial x}\mathbf{j} + \frac{\partial}{\partial x}\mathbf{k})V$
- field $\vec{\mathbf{E}} \equiv \frac{\vec{\mathbf{F}}}{q_{test}}$ $\vec{\mathbf{F}} = q\vec{\mathbf{E}}$
- flux $\Phi_E = \int_{surface} \vec{\mathbf{E}} \cdot d\vec{\mathbf{A}}$

Electrostatic equilibrium: no moving charge.

Current: moving charge $I = \frac{dQ}{dt}$

Capacitance: charge over potential $C \equiv \frac{Q}{\Delta V}$

Resistance: potential over current $R \equiv \frac{\Delta V}{I}$

Resistance and Resistivity (conductivity) and temperature: $\rho = \rho_o[1+\alpha(T-T_o)]$ $R = R_o[1+\alpha(T-T_o)]$

## Laws:

Coulomb's: force and charge. $\vec{\mathrm{F}}_{12} = k_e \frac{q_1 q_2}{r^2} \hat{\mathrm{r}}_{12} = \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{r^2} \hat{\mathrm{r}}_{12}$

Gauss's: electric flux and charge. $\Phi_E = \oint \vec{\mathrm{E}} \cdot d\vec{\mathrm{A}} = \frac{q}{\varepsilon_0}$

Ohm's: electric potential and current. $R \equiv \frac{\Delta V}{I}$

## Circuits and components:

Symbols: wire, battery, C, Switch…

Power: current times potential difference: $p = I \cdot \Delta V$

Capacitor: in parallel $C_{eq} = C_1 + C_2 + C_3 + \ldots$ in series $\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \ldots$

Resistor: discuss today