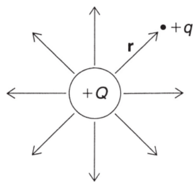
1. Coulomb's law

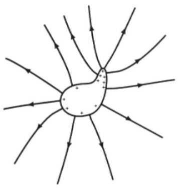
- $$F = \frac{kq_1q_2}{r^2}$$ (k≈9*10^9 N*m^2/C^2)
- $$k = \frac{1}{4\pi\varepsilon_0}$$ where ε0 represents vacuum

2. Electric field(E)

- $$\vec{E} = \frac{\vec{F}}{q}$$



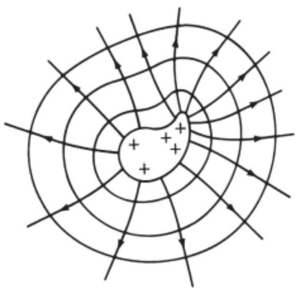
- **Figure 1.5 Drawing Electric Field Lines** (-Q 方向向里)



- 电场线的密集程度与曲率半径正相关（curvature）

3. Electric potential (V)

- V = kQ/r



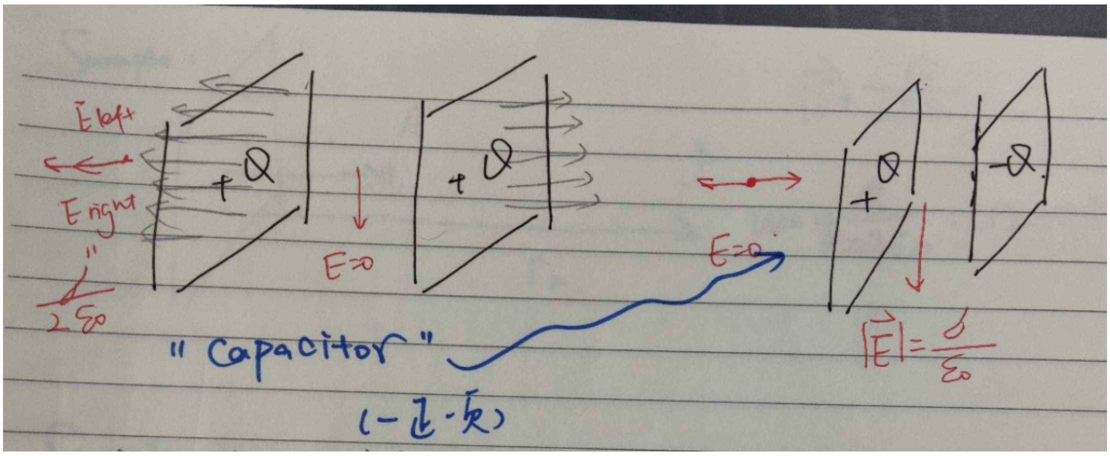
- Equipotential: the line is perpendicular to the electric field line

4. Work & Energy（J）

- W =-qΔV = −ΔPE
- Similarities in uniform gravitational and electrical formulas:

	Gravitational	Electrical
Forces	mg	qE
Potential Energy Differences	$mg\Delta h$	$qE\Delta x$

5. Capacitor (two plates that are oppositely charged)



fringe effect：the electric field loses its uniformity near the edges of the plates.

6.formulas

- 静电力 F (N)

  $F = \frac{kQ_1Q_2}{r^2}$ $\quad F = \frac{E}{\pm q}$

- 电场 E (N/C)

  $E = \frac{kQ}{r^2}$

- 电势 V (Nm/C) $\quad E = \frac{-\Delta V}{d}$

  $V = \frac{kQ}{r}$

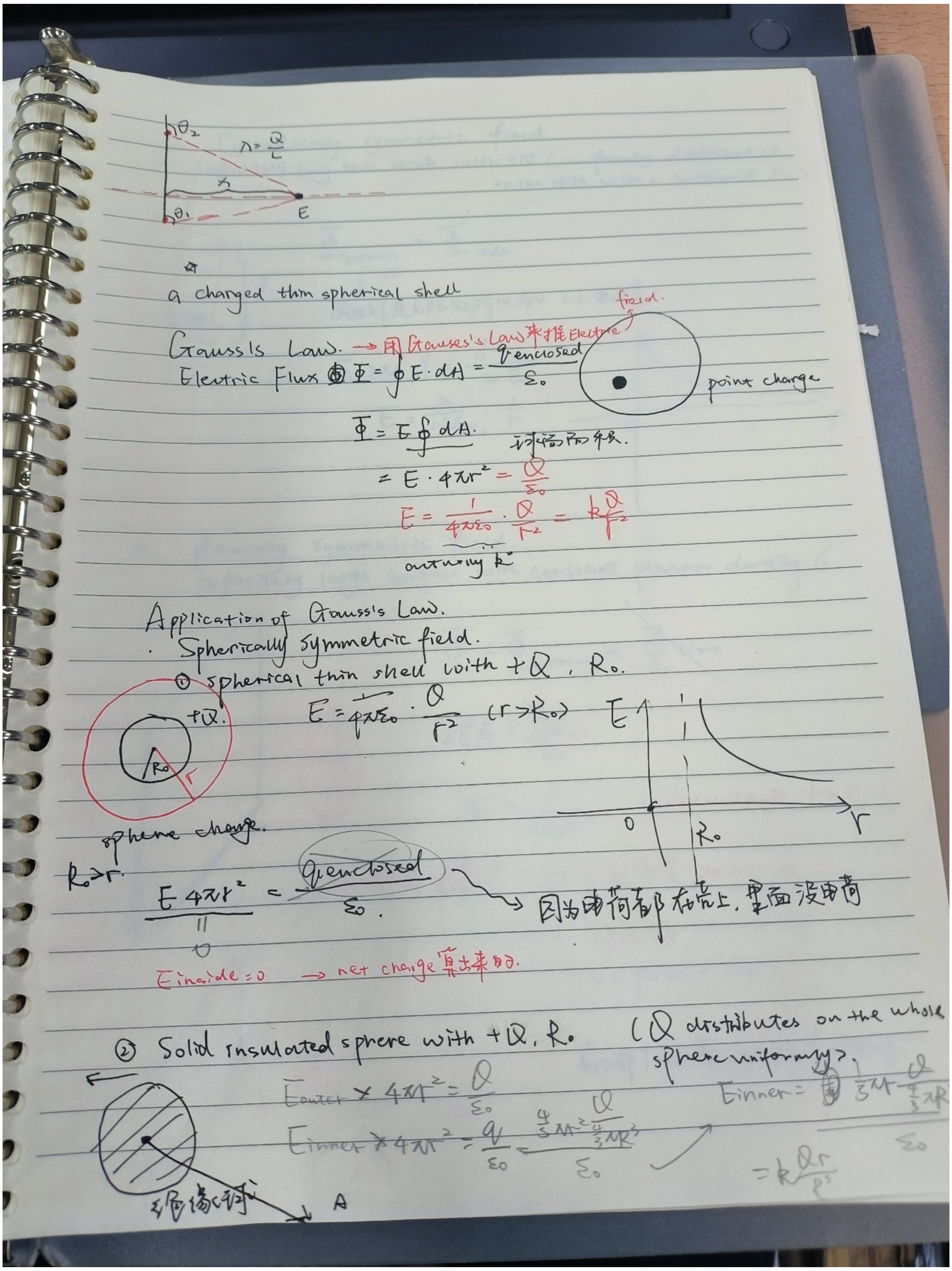
- 电势能 U_e (J) $\quad U_e = \pm q\Delta V$

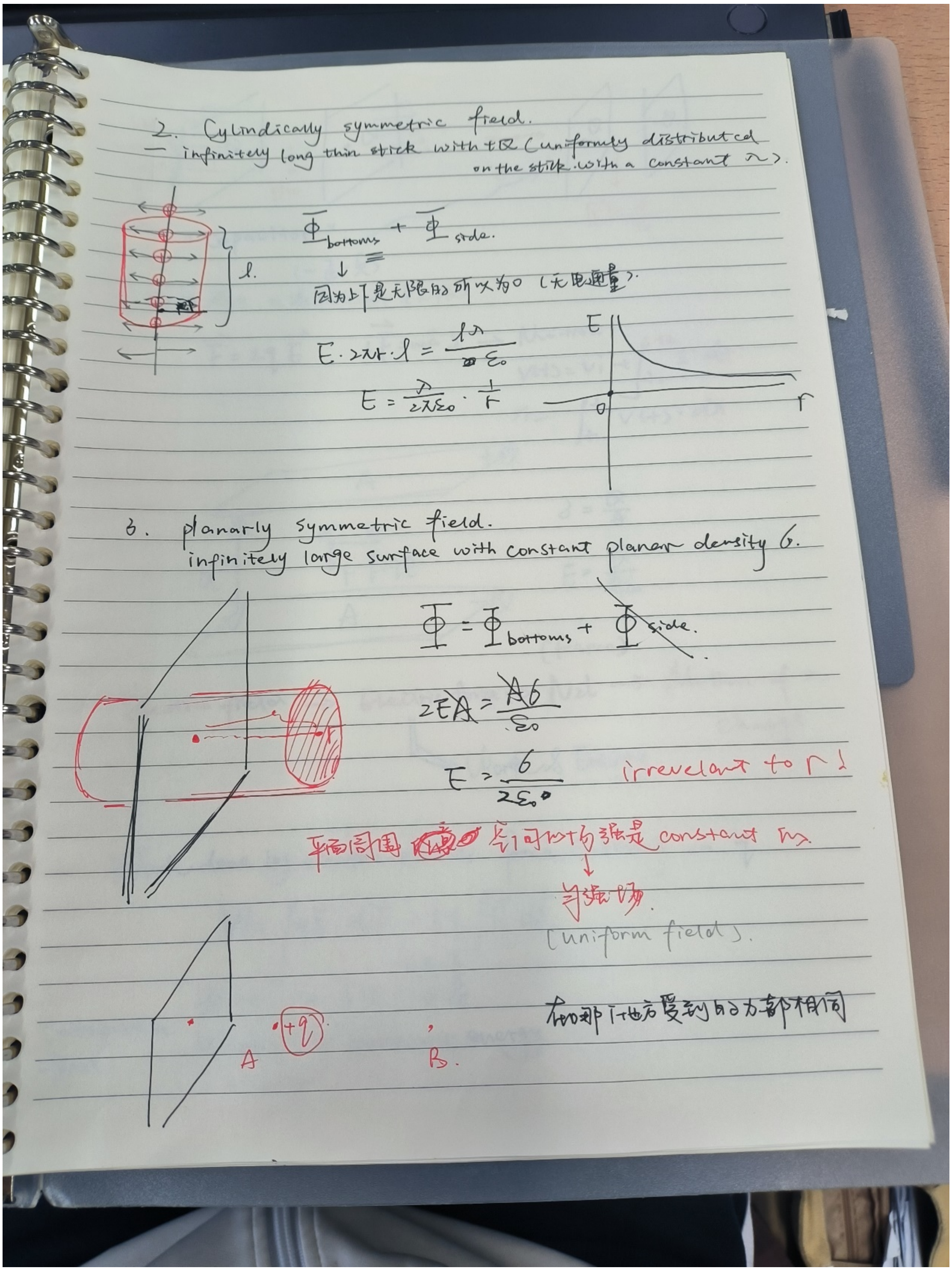
  $U_e = \frac{kQ_1Q_2}{r}$

- 功 W (J) $\quad W = -U_e = \pm qEd$

  $W = Fd = \Delta k$

6. Applications of Gauss's law





2. Cylindrically symmetric field.
— infinitely long thin stick with +Q (uniformly distributed on the stick. with a constant λ).

$\Phi_{bottoms} + \Phi_{side}$

因为上下是无限的所以为0（无电通量）.

$E \cdot 2\pi r \cdot l = \frac{l\lambda}{\varepsilon_0}$

$E = \frac{\lambda}{2\pi\varepsilon_0} \cdot \frac{1}{r}$

3. planarly symmetric field.
infinitely large surface with constant planar density σ.

$\Phi = \Phi_{bottoms} + \cancel{\Phi_{side}}$

$2E\cancel{A} = \frac{\cancel{A}\sigma}{\varepsilon_0}$

$E = \frac{\sigma}{2\varepsilon_0}$ irrevelant to r!

平面周围空间的场强是 constant 的.
↓
匀强场.
(uniform field).

+q

A

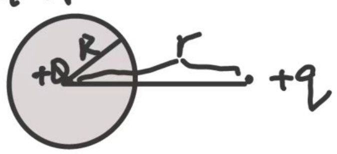
B.

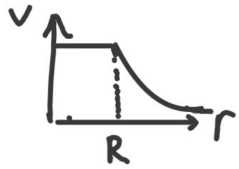
在哪个地方受到的力都相同

7. Work & energy in the uniform electric field
沿电场线做功电势能减小
For a positive charge，电势和电势能一致
For a negative charge，电势和电势能不一致

8. 带点球壳/实心球的电势

带电球壳

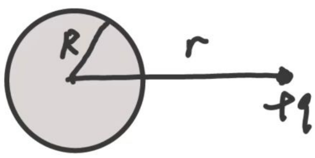




inside: $V = \frac{kQ}{R}$

outside: $V = \frac{kQ}{r}$

带电实心球



inside:

$W_{B \to \infty}$

$= \int_{r_B}^{R} \boxed{\frac{kQr}{R^3}} \cdot q \cdot dr + \int_{R}^{\infty}$

实心球场强（见高斯那章）

$= \dots$

$= \frac{1}{2} \frac{kQq}{R^3} (R^2 - r_B^2) + \frac{kQq}{R}$

二次函数

outside: $\frac{kQ}{r}$

9. Capacitor (A device that can store energy and charge) & capacitance
- Capacitance C（F）

$$C = Q/V = \varepsilon_0 A/d$$

-
- Potential energy: U = 1/2 QV
- $Q_e \to E = \frac{Q}{A\varepsilon_0} \to V_+ = \frac{Qd}{A\varepsilon_0} \to C = \frac{A\varepsilon_0}{d}$ (常量)