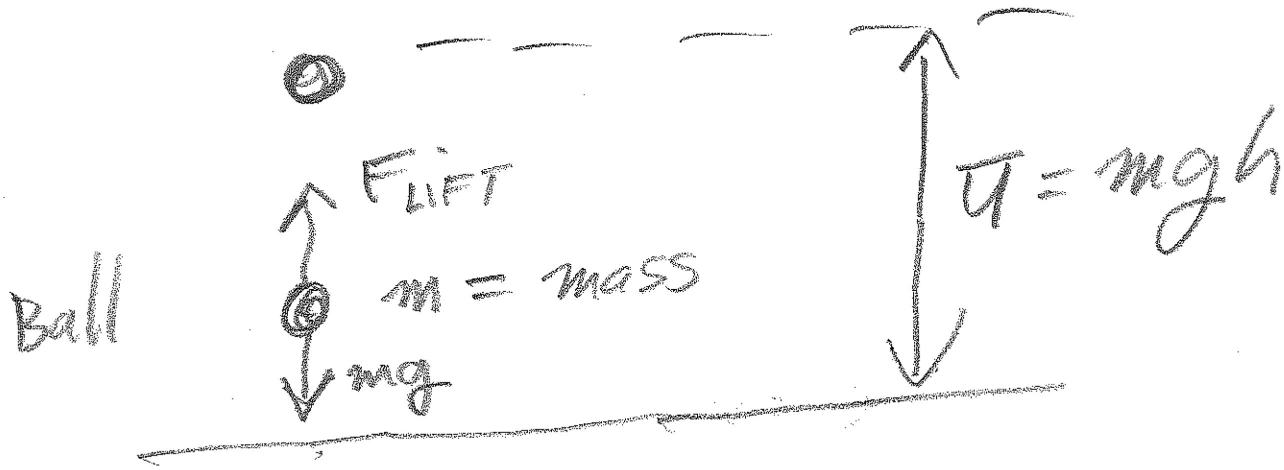
CH 23 ELECTRIC POTENTIAL

Electrical potential energy

sec 23.1

review potential energy

ALA CH 7.



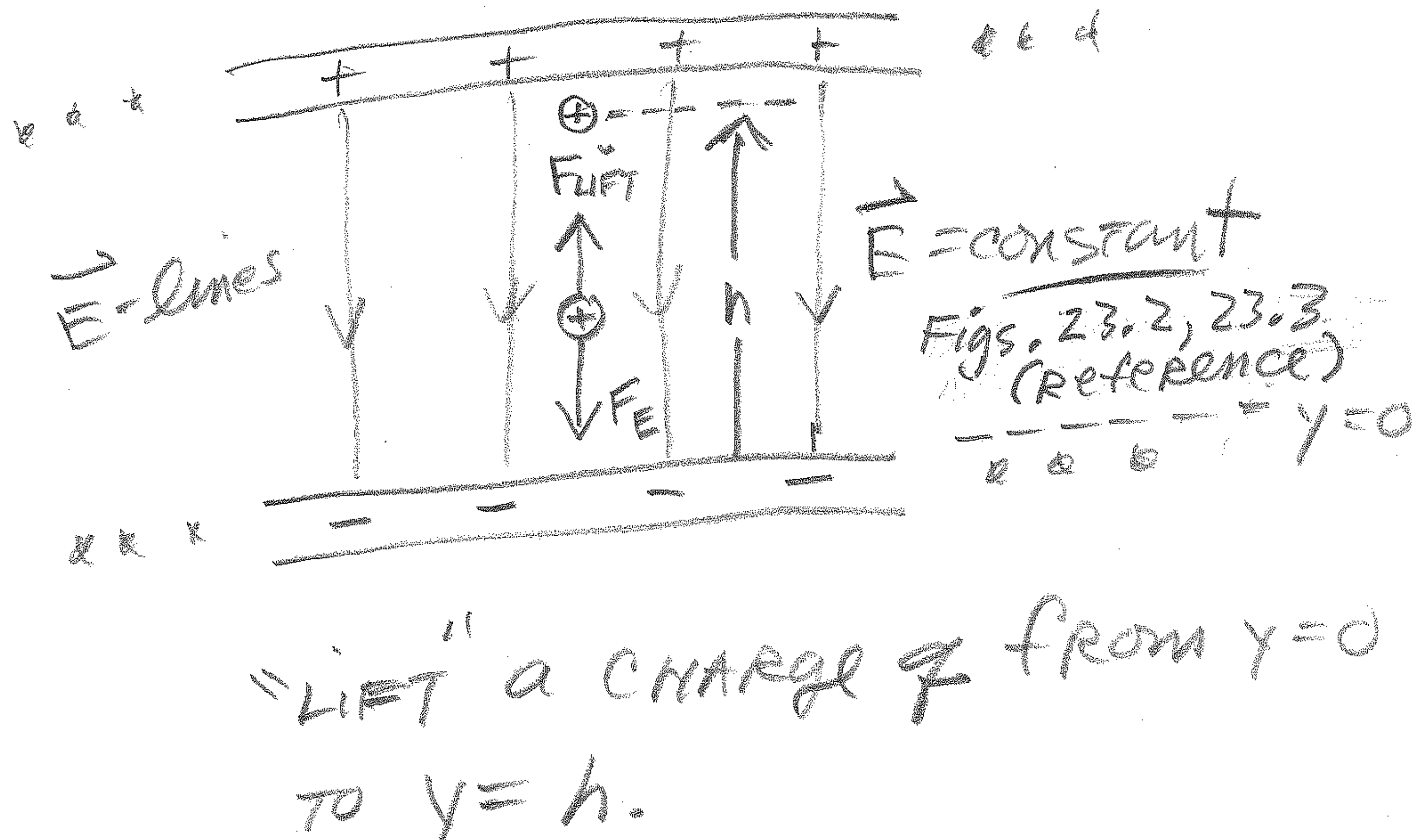
U = WORK you DO against gravity TO LIFT Ball from y = 0 TO y = h.

ASSUME $a_y = 0$;

$F_{LIFT} = mg$. THUS, $W_{YOU} = F_{LIFT}\, h$.

$$W_{you} = mgh \equiv U$$

sec 23.1

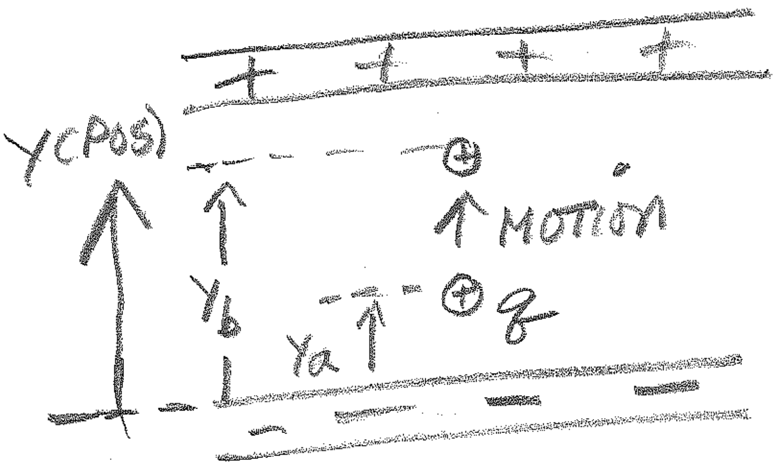


"LIFT" a CHARGE q FROM $y=0$ TO $y=h$.

NOTE: $F_E \equiv q \cdot E$

$$W_{you} = F_E \cdot h = q \cdot Eh$$

$$U = q \cdot E \cdot h \quad \text{EQN. 23.4} \quad \text{EQN. 23.5}$$



$$\Delta U = qE(y_b - y_a)$$

note: $W_{field} = -\Delta U = qE(y_a - y_b)$

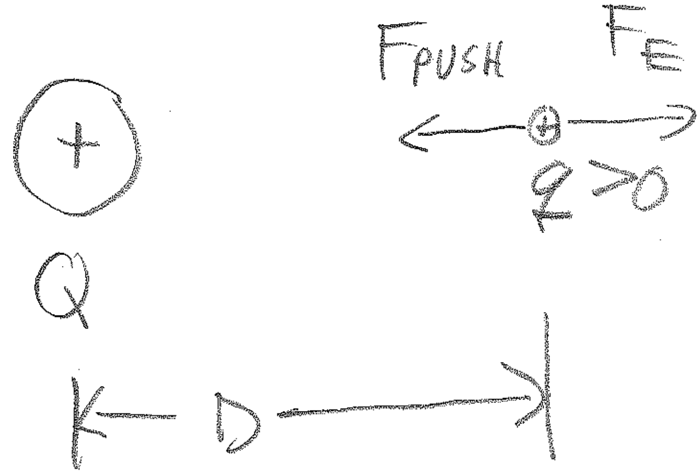
NOTE: IF $q > 0$

(A.) $\Delta U > 0$ when you move q AWAY from − plate TOWARD + plate.

(B.) $\Delta U < 0$ when you move q TOWARD − plate from + plate, sec 23.1

potential energy of 2 point charges. Let Q be a point charge near another charge q.

$$F_E = qE$$

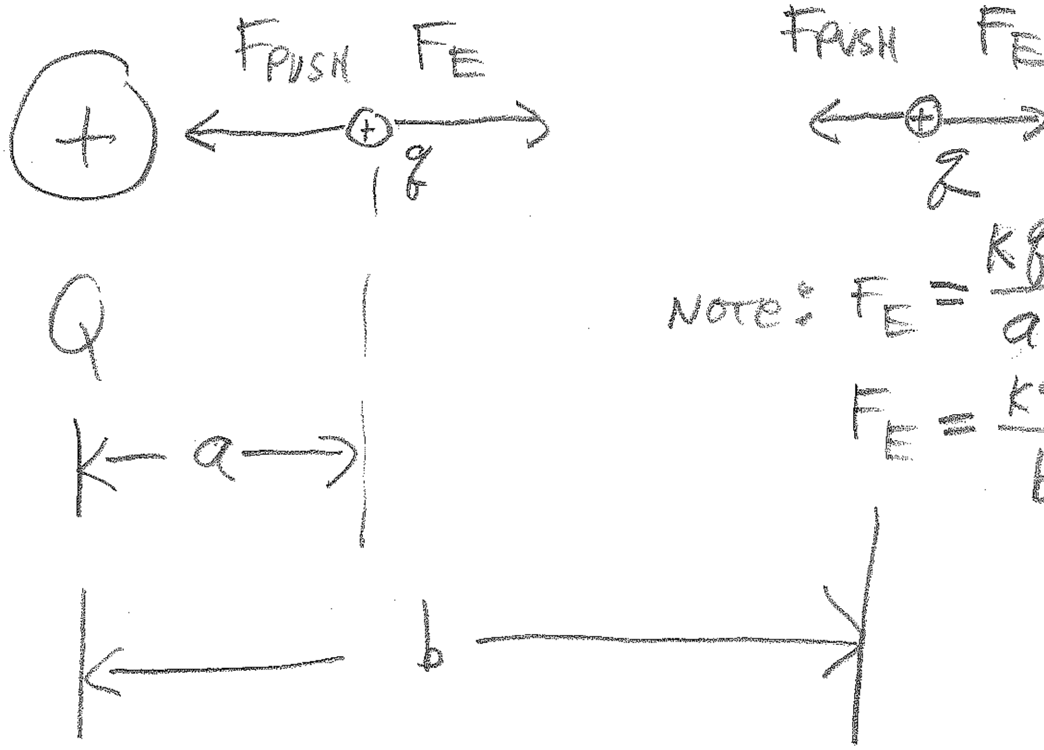


where

$$E = \frac{KQ}{D^2}$$

$$F_E = q \cdot E = q \cdot \left(\frac{KQ}{D^2}\right)$$

$$F_E = \frac{KqQ}{D^2}$$



NOTE: $F_E = \frac{kqQ}{a^2}$ AT a.

$F_E = \frac{kqQ}{b^2}$ AT b.

$$W_{you} \neq F_{push} \cdot (b-a) = F_E \cdot (b-a)$$

Reason: F_E and F_{PUSH} depend on distance: $F_E = \frac{kqQ}{(\text{distance})^2}$

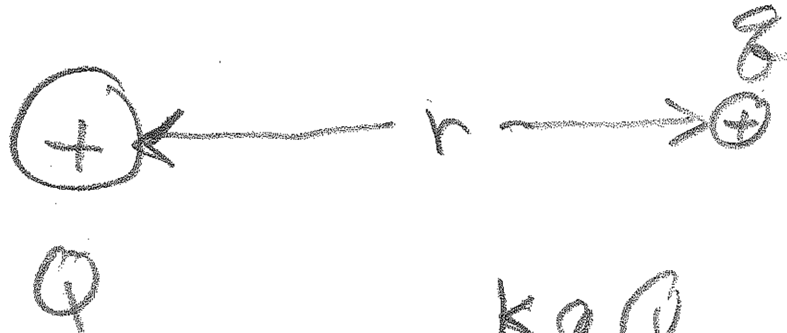
calculus RESULT (see APPendix)

$$W_{you} = kqQ\left[\frac{1}{a} - \frac{1}{b}\right] = \Delta U = U_a - U_b$$

$$U_a = \frac{kqQ}{a}$$

$$U_b = \frac{kqQ}{b}$$

In general:

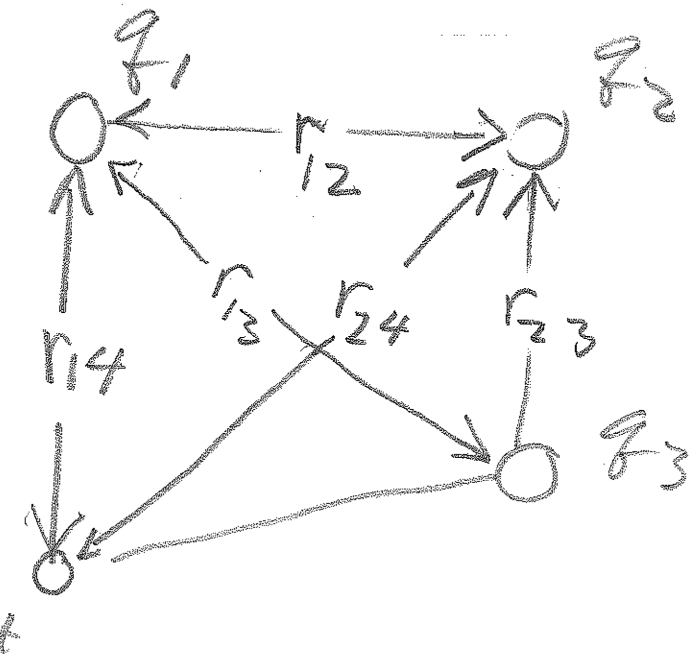


$$U = \frac{kqQ}{r}$$ (Potential energy of 2 point charges)

<u>NOTE</u>: (i) $\Delta U > 0$ when you move q TOWARD + CHARGE Q.

(ii) $\Delta U < 0$ WHEN YOU MOVE q AWAY FROM + CHARGE Q.

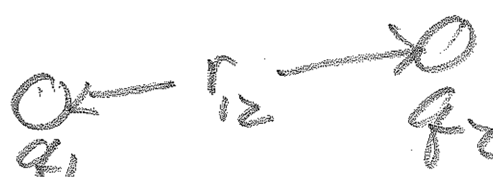
Electric potential energy of several point charges:



6 pairs: 6 terms in potential energy; for N charges, there are $\frac{N\cdot(N-1)}{2}$ pairs.

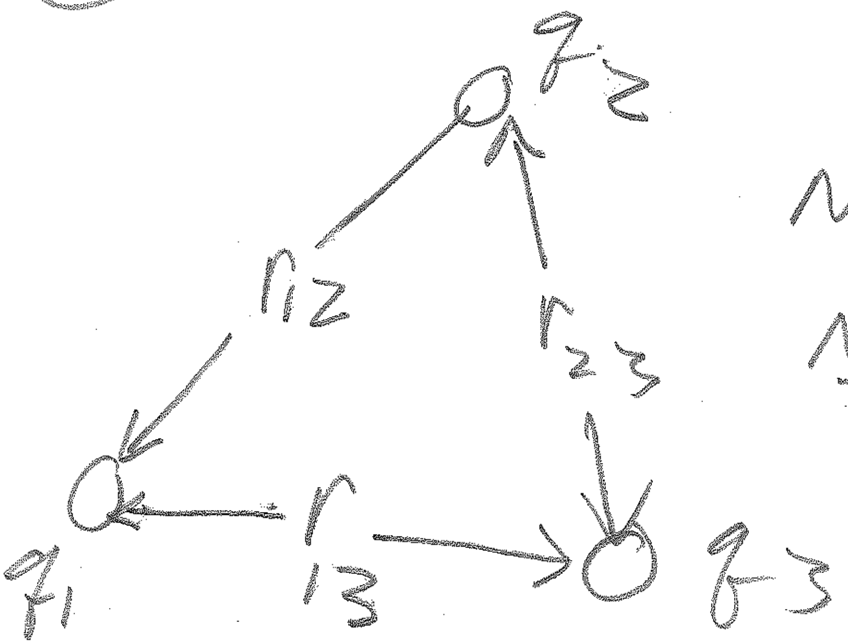
Examples:

(A) 2 charges $N = 2 \rightarrow \frac{2\cdot(2-1)}{2} = 1$ pair



$$U = \frac{k q_1 q_2}{r}$$

(B) 3 particles:



$N = 3;$

$$\frac{N(N-1)}{2} = \frac{3(3-1)}{2} = \frac{3 \cdot 2}{2} = 3 \text{ PAIRS}$$

$$U = \frac{kq_1q_2}{r_{12}} + \frac{kq_1q_3}{r_{13}} + \frac{kq_2q_3}{r_{23}}$$

(C) TRY THIS OUT FOR 4 CHARGES:
6 PAIRS and 6 TERMS
for U.

2-5-14

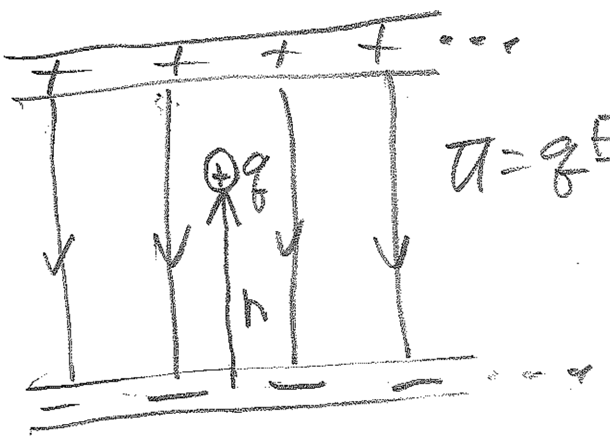
~~Potential~~ — Sec 23.2

ΔV = CHANGE IN POTENTIAL $\left[\frac{J}{C}\right] \equiv [V]$

$$\Delta V \equiv \frac{\Delta U}{q}, \quad q = \text{test charge}$$

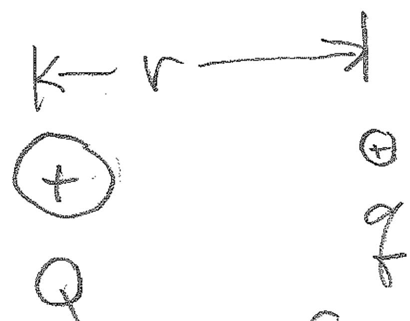
U - view

(i) $\vec{E}$ = constant



$U = qEh$

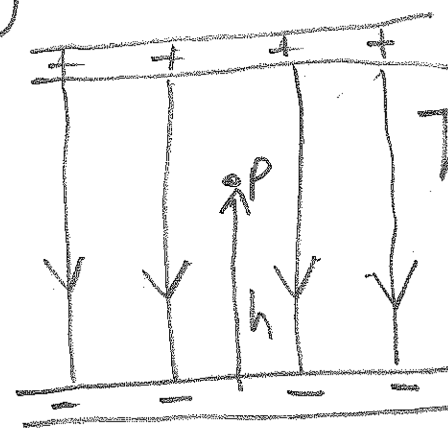
(ii) $\vec{E} \neq$ constant



$$U = \frac{kqQ}{r}$$

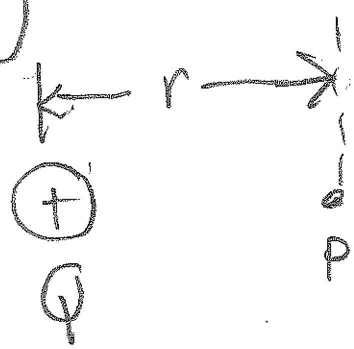
V - view

(i)



$V = E \cdot h$

(ii)

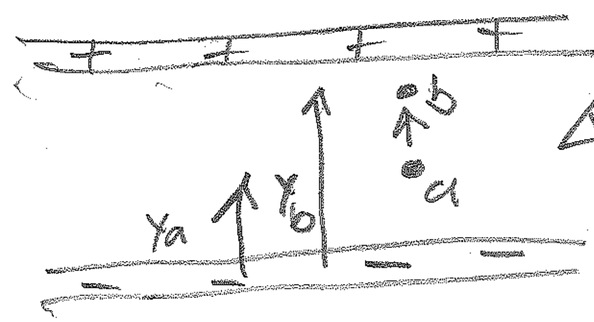


$$V = \frac{kQ}{r}$$

NOTE: P = POINT IN SPACE.

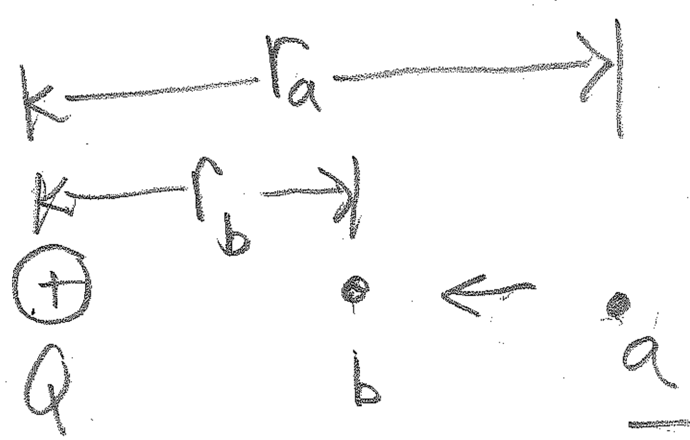
NOTE:

(i) $\Delta V > 0$ as you move TOWARD + PLATE (AWAY from − plate)



$$\Delta V = E(y_b - y_a) > 0$$

(ii)



$$\Delta V = kQ\left[\frac{1}{b} - \frac{1}{a}\right] > 0$$

$\Delta V > 0$ as you move TOWARD $Q > 0$.