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Date

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(1) Q C V W

$$2a^2\pi E = \frac{Q}{\varepsilon_0} \qquad E = \frac{Q_0}{2a^2\pi\varepsilon_0}$$ → $\frac{1}{2}$ 4

$$C = \varepsilon_0\frac{a^2\pi}{D} \qquad Q = CV \quad V = \frac{Q}{C} = \frac{D}{\varepsilon_0 a^2\pi}\cdot Q_0$$

$$= \frac{DQ_0}{a^2\pi\varepsilon_0}$$ 4

(2) $$F_E = q E = Q_0 E = \frac{Q_0^2}{2a^2\pi\varepsilon_0}$$ ($\frac{1}{2}$) 4

(3) Q C V W

Q_0 $\varepsilon_0\frac{a^2\pi}{D}$ $\frac{1}{2}\frac{D}{0}$

Q_0 $\varepsilon_0\frac{a^2\pi}{D+\Delta x}$ $\frac{1}{2}\frac{D+\Delta x}{0}$

$$Q = CV$$

$$V = \frac{Q}{C}$$

$$\frac{1}{2}QV = \frac{1}{2}CV^2 = \frac{1}{2}\frac{Q_0^2}{C}$$

$$\Delta U = \frac{1}{2}\frac{D+\Delta x}{0} - \frac{1}{2}\frac{D}{0}$$

$$= \frac{Q^2}{2}\Delta x$$

(4) $$U = \frac{1}{2}\frac{Q_0^2}{C} = \frac{Q_0^2}{2}\left(\frac{1}{\varepsilon}\frac{X}{a^2\pi}\right) = \frac{Q_0^2 X}{2\varepsilon_0 a^2\pi}$$ 4

(5) Q C V W

Q_0 $\frac{a^2\pi\varepsilon_0}{D}$ $\frac{DQ_0}{a^2\pi\varepsilon_0}$

Q' $\frac{a^2\pi\varepsilon_0}{D+\Delta X}$ 〃

$$Q' = \frac{\frac{DQ_0}{a^2\pi\varepsilon_0}}{D+\Delta X}$$

$$U_1 = \frac{1}{2}CV^2 = \frac{1}{2}\frac{a^2\pi\varepsilon_0}{D}\left(\frac{DQ_0}{a^2\pi\varepsilon_0}\right)^2 =$$

$$U_2 = \frac{1}{2}\frac{a^2\pi\varepsilon_0}{D+\Delta X}\left(\frac{DQ_0}{a^2\pi\varepsilon_0}\right)^2 =$$

$$U_2 - U_1 = \frac{1}{2}a^2\pi\varepsilon_0\left(\frac{DQ_0}{a^2\pi\varepsilon_0}\right)^2\left(\frac{1}{D+\Delta X} - \frac{1}{D}\right)$$

(5) $Q \quad V \quad C \quad W$

$Q_0 \quad V \quad C \quad \frac{1}{2}Q_0V$

$Q' \quad V \quad C' \quad \frac{1}{2}Q'V$

$$\Delta U = \frac{1}{2}Q'V - \frac{1}{2}Q_0V = \frac{V}{2}(Q' - Q_0)$$

$$Q' = C'V$$

$$= \varepsilon_0 \frac{S}{D+\Delta x} \times \frac{DQ_0}{S\varepsilon_0} = Q_0 \frac{D}{D+\Delta x}$$

$$\Delta U = \frac{V}{2}\left(Q_0\frac{D}{D+\Delta x} - Q_0\right) = \frac{VQ_0}{2}\left(\frac{1}{1+\frac{\Delta x}{D}} - 1\right)$$

$$= \frac{V}{2}Q_0\left(\frac{-\Delta x}{D+\Delta x}\right) \quad \fallingdotseq \frac{VQ_0}{2}\left(1 - \frac{\Delta x}{D} - 1\right)$$

$$= \frac{Q_0}{2}\frac{DQ_0}{S\varepsilon_0}\left(\frac{-\Delta x}{D+\Delta x}\right) \quad = \frac{Q_0}{2}\frac{DQ_0}{S\varepsilon_0}\left(-\frac{\Delta x}{D}\right)$$

$$\fallingdotseq \frac{Q_0^2}{2}\frac{-\Delta x}{\varepsilon_0 S}(D - \Delta x) \quad = \frac{Q_0^2}{2S\varepsilon_0}(-\Delta x)$$

$$\fallingdotseq -\frac{Q_0^2}{2}\frac{D\Delta x}{\varepsilon_0 S} \quad = \frac{-Q_0^2}{2\varepsilon_0 S}\Delta x$$

スイッチを閉じたときには、極板間キョリが離れても、電池がエネルギーを与えることでQを一定に保ったが、スイッチを開けたときは、外力が負の仕事をしたのみなので、エネルギーが減少した。