H27

P91

(1)

$$\int E_A \, dS = \frac{\lambda}{\varepsilon_0}$$

$$E_A = \frac{\lambda}{2\pi x \varepsilon_0}$$

$$\int E_B \, dS = \frac{\lambda}{\varepsilon_0}$$

$$E_B = \frac{\lambda}{2\pi (d-x) \varepsilon_0}$$

$$E = E_A + E_B$$

$$= \frac{\lambda}{2\pi\varepsilon_0}\left(\frac{1}{x} + \frac{1}{d-x}\right)$$

(2)

$$\phi_{AB} = -\int_{d-a}^{a} E \, dx$$

$$= \frac{\lambda}{2\pi\varepsilon_0}\left[\log x - \log(d-x)\right]_{d-a}^{a}$$

$$= \frac{\lambda}{2\pi\varepsilon_0} \log \frac{a}{d-a} \frac{d-a}{a}$$

$$= \frac{\lambda}{\pi\varepsilon_0} \log \frac{d-a}{a}$$

(3) $Q = CV$ より

$$C = \frac{Q}{V} = \frac{\lambda}{\phi_{AB}}$$

$$= \frac{\pi\varepsilon_0}{\log \frac{d-a}{a}}$$

(4)

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

$$= \frac{\pi\varepsilon_0}{2\log \frac{d-a}{a}} V_0^2$$

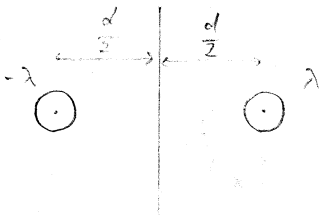
(5)

$$F = \frac{\partial U}{\partial d}$$

$$= -\frac{-\frac{2\pi\varepsilon_0 d}{d-a}}{(2\log \frac{d-a}{a})^2} = -\frac{2\pi\varepsilon_0 d}{(d-a)(2\log \frac{d-a}{a})^2}$$

$F < 0$ なので吸収力

(6) 影像法を用いる



$$E = \frac{\lambda}{2\pi\varepsilon_0}\left(\frac{1}{x} + \frac{1}{d-x}\right)$$

$$V = \frac{\lambda}{\pi\varepsilon_0} \log \frac{d-a}{a}$$

$d \gg a$ より $d - a \approx d$

$$V \approx \frac{\lambda}{\pi\varepsilon_0} \log \frac{d}{a}$$

影像法により $V' = \frac{V}{2}$

$$C = \frac{\lambda}{V'} = \frac{2\pi\varepsilon_0}{\log \frac{d}{a}}$$