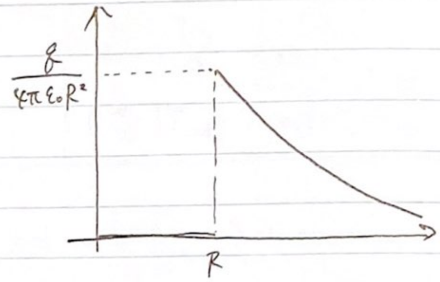
2018 中大 前期 電磁気

①(1)

r < R のとき　$E = 0$

r > R のとき　$4\pi r^2 \cdot E = \dfrac{q}{\varepsilon_0}$

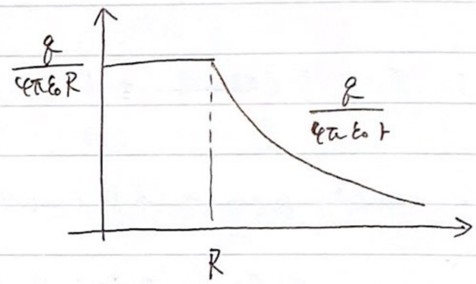
$$E = \frac{q}{4\pi\varepsilon_0}\frac{1}{r^2}$$



(2) r > R のとき

$$V = -\int_\infty^{r} \frac{q}{4\pi\varepsilon_0}\frac{1}{r'^2}dr'$$

$$= \frac{q}{4\pi\varepsilon_0}\frac{1}{r}$$



(3)
- 導体内部の電場は0
- 電荷は導体表面に分布
- 導体表面では電気力線は面に垂直に交わる
- 導体表面では電位が等しい

(4)

$$U = \frac{1}{2}\int \varepsilon_0 E^2 dV$$

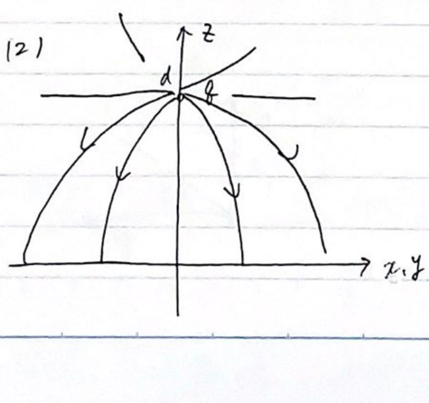
$$= \frac{1}{2}\int_R^\infty \varepsilon_0 \left(\frac{q}{4\pi\varepsilon_0}\right)^2 \frac{1}{r^4} 4\pi r^2 dr$$

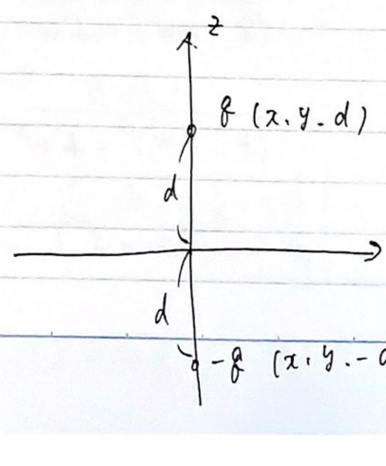
$$= \frac{1}{8}\frac{q^2}{\pi\varepsilon_0 R}$$

$\dfrac{4\pi r^3}{3} = V$

$4\pi r^2 dr = dV$

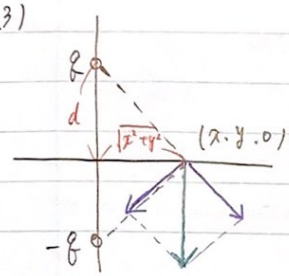
②(1)(2)





No.
Date.

(3)



$$E_z = \frac{2q}{4\pi\varepsilon_0}\frac{1}{(x^2+y^2+d^2)^{\frac{3}{2}}}\frac{d}{\sqrt{x^2+y^2+d^2}}$$

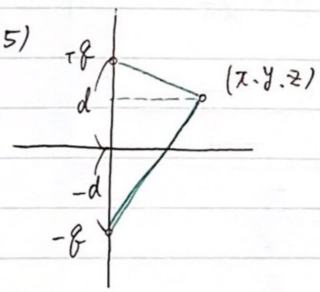
$|\vec{r}|^2 = r^2$

$$= \frac{qd}{2\pi\varepsilon_0}\frac{1}{(d^2+r^2)^{\frac{3}{2}}}$$

(4) 物体内部が $E=0$ だと $\sigma = D$ (電荷密度 = 電束密度)

$$\sigma = D = \frac{qd}{2\pi}\frac{1}{(d^2+r^2)^{\frac{3}{2}}}$$

(5)



$$V = \frac{q}{4\pi\varepsilon_0}\left\{\frac{1}{\sqrt{x^2+y^2+(z-d)^2}} - \frac{1}{\sqrt{x^2+y^2+(z+d)^2}}\right\}$$

+q の電位　　-q の電位

(6)

$$V = \frac{q}{4\pi\varepsilon_0}\left\{\left(r^2+(z-d)^2\right)^{-\frac{1}{2}} - \left(r^2+(z+d)^2\right)^{-\frac{1}{2}}\right\}$$

$$= \frac{q}{4\pi\varepsilon_0}\left\{r^2\left(1+\frac{-2zd+d^2}{r^2}\right)^{-\frac{1}{2}} - r^2\left(1+\frac{+2zd+d^2}{r^2}\right)^{-\frac{1}{2}}\right\}$$

$$= \frac{q}{4\pi\varepsilon_0}r^2\left(1+\frac{zd}{r^2}-\frac{d^2}{2r^2}-1+\frac{zd}{r^2}+\frac{d^2}{2r^2}\right)$$

$$= \frac{q}{4\pi\varepsilon_0}2dz$$