① (a) $A = \pi R^2$

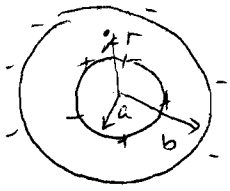
$$C = \frac{\epsilon A}{d} = \frac{(8.85\ pf/m)(\pi)(0.052\ m)^2}{0.0013\ m} = 140\ pf$$

(b) $$Q = C\Delta V = (140 \times 10^{-12}\ F)(12V) = 1.7 \times 10^{-9} C$$

② $$Q = C\Delta V = (0.055 \times 10^{-12}\ F)(5.3V) = 2.9 \times 10^{-13} C$$

$$\times \frac{1\ e^-}{1.6 \times 10^{-19} C} = 1.8 \times 10^6\ e^-$$

③



(a)

at r $$E = \frac{1}{4\pi\epsilon_0}\frac{Q}{r^2}$$

$$\Delta V = \int_+^- E\,dr = \int_a^b \frac{Q}{4\pi\epsilon_0}\frac{dr}{r^2} = \frac{Q}{4\pi\epsilon_0}\left(-\frac{1}{r}\right)_a^b$$

$$= \frac{Q}{4\pi\epsilon_0}\left(\frac{1}{a} - \frac{1}{b}\right) = \frac{Q}{4\pi\epsilon_0}\frac{b-a}{ab} = \frac{Q}{C}$$

$$C = 4\pi\epsilon_0\, ab/(b-a)$$

(b) let $b \to \infty$

$$C = 4\pi\epsilon_0 a = (9 \times 10^9)^{-1}(6.37 \times 10^6 m) = 710\,\mu F$$

④ at r $$E = \frac{Q}{2\pi\epsilon_0 L}\frac{1}{r}$$

(a) $$\Delta V = \int_+^- E\,dr = \int_a^b \frac{Q}{2\pi\epsilon_0 L}\frac{dr}{r} = \frac{Q}{2\pi\epsilon_0 L}\ln r\Big|_a^b$$

$$= \frac{Q}{2\pi\epsilon_0 L}(\ln b - \ln a) = \frac{Q}{2\pi\epsilon_0 L}\ln\frac{b}{a} = \frac{Q}{C}$$

$$C = 2\pi\epsilon_0 L/\ln(b/a)$$

(b) $$C = (2\pi)(8.85\ pf/m)(1m)/\ln(2.1mm/0.15mm) = 21\ pF$$