

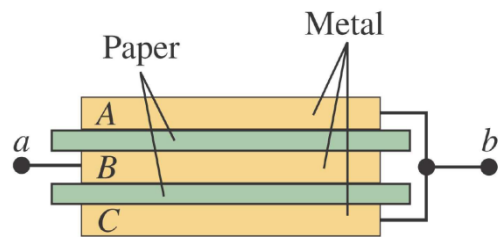
PC1432 PHYSICS IIE

Tutorial Exercise 2

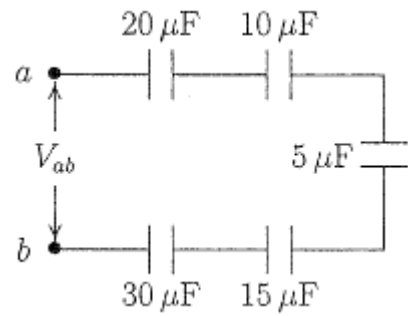
1. (a) [Y&F 23.72] From the expression for $E(r)$ obtained in the section of Chapter 22: field of a uniformly charged sphere, find the expression for the electric potential $V(r)$ as a function of r both inside and outside the uniformly charged sphere. Assume that $V = 0$ at infinity. [Answer: Outside: $V = \frac{Q}{4\pi\epsilon_0 r}$; Inside: $V = \frac{Q}{8\pi\epsilon_0 R} \left[3 - \frac{r^2}{R^2} \right]$]
 (b) [Y&F 23.73] Charge $Q = +4.0 \mu\text{C}$ distributed uniformly over the volume of an insulating sphere that has radius $R = 5.00 \text{ cm}$. What is the potential difference between the centre of the sphere and the surface of the sphere? [Answer: $3.60 \times 10^5 \text{ V}$]

2. Positive electric charge Q is distributed uniformly along a thin rod of length $2a$. The rod lies along the x -axis between $x = -a$ and $x = +a$. Calculate how much work you must do to bring a positive point charge q from infinity to the point $x = +L$ on the x -axis, where $L > a$. [Answer: $U = \frac{qQ}{8\pi\epsilon_0 a} \ln \left(\frac{L+a}{L-a} \right)$]

3. [Y&F 24.75] Three square metal plates A, B, and C, each 12.0 cm on a side and 1.50 mm thick, are arranged as in the figure. The plates are separated by sheets of paper 0.45 mm thick and with dielectric constant 4.2. The outer plates are connected together and connected to point b . The inner plate is connected to point a .
 (a) Show by plus and minus signs the charge distribution on the plates when point a is maintained at a positive potential relative to point b .
 (b) What is the capacitance between points a and b ? [Answer: 2.38 nF]



4. Five capacitors in series are connected across a potential difference V_{ab} as shown on the right. Because of the dielectrics used, each capacitor will break down if the potential across it exceeds 30 V (i.e. the maximum working voltage across each capacitor is 30 V.). What is the largest value of V_{ab} that can be applied without damaging any of the capacitors?



[Answer: 67.5 V]

5. Consider n identical batteries, each with emf E and internal resistance r , connected to an external resistor R . If the current through the external resistor is the same whether the batteries are connected in series or parallel, what is the internal resistance r ?

[Answer: $r = R$]