Instituto de Física

FAP 2292

Gabarito – Lista de Exercícios 4
Capacitância e dielétricos

Exercícios Sugeridos (18/03/2010) A numeração corresponde ao Livros Textos A e B.

A20.66 (a) $C = \frac{\epsilon_0 \ell^2}{d}\left[1 + \frac{x}{\ell}(k-1)\right]$; (b) $U = \frac{1}{2}CV^2 = \frac{\epsilon_0 \ell^2}{2d}\left[1 + \frac{x}{\ell}(k-1)\right]V^2$
(c) $F = \frac{\partial U}{\partial x} = \frac{\epsilon_0 \ell}{2d}(k-1)V^2$ (para dentro das placas); (d) $F = 1{,}55\times 10^{-3}$ N.

A20.76 a) $V \approx \frac{1}{4\pi\epsilon_0}\frac{p\cos\theta}{r^2}$. b) $E_r = -\frac{\partial V}{\partial r} = \frac{1}{4\pi\epsilon_0}\frac{2p\cos\theta}{r^3}$; $E_\theta = -\frac{1}{r}\frac{\partial V}{\partial\theta} = \frac{1}{4\pi\epsilon_0}\frac{p\,\mathrm{sen}\,\theta}{r^3}$.
c) $V(x,y,z) = \frac{p}{4\pi\epsilon_0}\frac{y}{r^3}$, com $r = \left(x^2+y^2+z^2\right)^{3/2}$
$E_x = -\frac{\partial V}{\partial x} = \frac{p}{4\pi\epsilon_0}\frac{3xy}{r^5}$; $E_y = -\frac{\partial V}{\partial y} = \frac{p}{4\pi\epsilon_0}\frac{2y^2 - x^2 - z^2}{r^5}$; $E_z = -\frac{\partial V}{\partial z} = \frac{p}{4\pi\epsilon_0}\frac{3zy}{r^5}$;

A20.77 (a) $U = \frac{1}{2}\frac{Q^2}{C} : C_0 \to C = \kappa C_0 \Rightarrow U = \frac{1}{\kappa}U_0$; (b) $U = \frac{1}{2}CV^2 : C_0 \to C = \kappa C_0 \Rightarrow U = \kappa U_0$.
Nos dois casos energia é retirada do sistema pelo trabalho mecânico da força externa sobre o dielétrico. No segundo caso, a bateria fornece energia ao sistema ao aumentar a carga para manter a diferença de potencial constante.

H.37E $c = \frac{2\pi\epsilon_0}{\ln(r_2/r_1)} = 81\ \mathrm{pF/m}$; $Q_0 = \lambda_0 L = CV = 81\ \mathrm{nC}$;
Entre os condutores:$D_\rho = \kappa\epsilon_0 E_\rho = \frac{\lambda_0}{2\pi\rho}$; $P_\rho = D_\rho - \epsilon_0 E_\rho = \frac{\lambda_0}{2\pi\rho}(1 - 1/\kappa)$.
$Q_p = \pm Q_0(1 - 1/\kappa) = \pm 50$ nC.

H.40P $E_1 = E_2 = \frac{2}{\kappa_1+\kappa_2}\frac{Q_0}{\epsilon_0 A}$; $V = E_1 d = E_2 d = Q_0/C \Rightarrow C = \frac{\epsilon_0 A}{d}\frac{\kappa_1+\kappa_2}{2}$;
$D_1 = \kappa_1\epsilon_0 E_1 = \frac{\kappa_1}{\kappa_1+\kappa_2}\frac{Q_0}{A}$, $D_2 = \kappa_2\epsilon_0 E_2 = \frac{\kappa_2}{\kappa_1+\kappa_2}\frac{Q_0}{A}$;
$P_1 = (\kappa_1 - 1)\epsilon_0 E_1 = \frac{2(\kappa_1-1)}{\kappa_1+\kappa_2}\frac{Q_0}{A}$, $P_2 = (\kappa_2 - 1)\epsilon_0 E_2 = \frac{2(\kappa_2-1)}{\kappa_1+\kappa_2}\frac{Q_0}{A}$.

H.41P $D_1 = D_2 = \frac{Q_0}{A}$; $E_1 = \frac{Q_0}{\kappa_1\epsilon_0 A}$; $E_2 = \frac{Q_0}{\kappa_2\epsilon_0 A}$;
$V = E_1(d/2) + E_2(d/2) = \frac{Q_0 d}{\epsilon_0 A}\frac{\kappa_1+\kappa_2}{2\kappa_1\kappa_2} \Rightarrow C = \frac{\epsilon_0 A}{d}\frac{2\kappa_1\kappa_2}{\kappa_1+\kappa_2}$;
$P_1 = (\kappa_1-1)\epsilon_0 E_1 = (1 - 1/\kappa_1)\frac{Q_0}{A}$, $P_2 = (\kappa_2-1)\epsilon_0 E_2 = (1-1/\kappa_2)\frac{Q_0}{A}$.

P1.4 (a) $D_r = -\frac{Q_0}{4\pi r^2}$; $E_r = -\frac{1}{\kappa}\frac{Q_0}{4\pi\epsilon_0 r^2}(a < r < b)$ $E_r = -\frac{Q_0}{4\pi\epsilon_0 r^2}(b < r < c)$;
(c) $P_r = -\frac{\kappa - 1}{\kappa}\frac{Q_0}{4\pi r^2}(a < r < b)$; (d) $C = \frac{4\pi\epsilon_0 b}{(b/a - 1)/\kappa + (1 - b/c)}$.

24.29 a) $U = \frac{1}{2}\frac{Q^2}{C} = \frac{1}{2}\frac{Q^2}{\epsilon_0 A}x$ b) $dU = \frac{1}{2}\frac{Q^2}{\epsilon_0 A}dx$ c) $F = \frac{dU}{dx} = \frac{1}{2}\frac{Q^2}{\epsilon_0 A} = \frac{1}{2}QE$
d) A força sobre uma placa é devida apenas ao campo da outra placa.