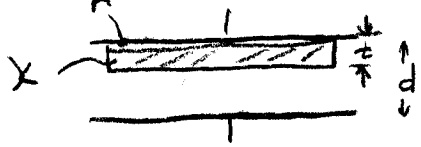
24-66 GIVEN: PARALLEL PLATE CAPACITOR (PPC)
PLATE SEPARATION $= d$ CAPACITANCE $= C_0$
SLAB INSERTED $(t < d,\ \kappa)$

FIND: NEW CAPACITANCE



$$\frac{1}{C_{eq}} = \frac{1}{C_{DIELC}} + \frac{1}{C_{AIR}}$$

$$C_0 = \frac{\epsilon_0 A}{d} \qquad C_{AIR} = \frac{\epsilon_0 A}{d-t}\left(\frac{d}{d}\right) = \frac{d}{d-t} C_0$$

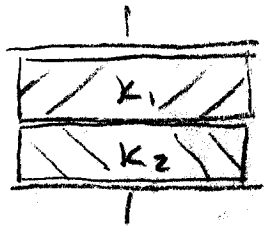
$$C_{DIELC} = \frac{\kappa \epsilon_0 A}{t}\left(\frac{d}{d}\right) = \frac{\kappa d}{t} C_0$$

$$\frac{1}{C_{eq}} = \left(\frac{\kappa}{\kappa}\right)\frac{d-t}{d\,C_0} + \frac{t}{\kappa d C_0} = \frac{\kappa(d-t)+t}{\kappa d C_0}$$

$$\boxed{C_{eq} = \frac{\kappa C_0\, d}{\kappa(d-t)+t} = \kappa C_0\left(\frac{d}{\kappa d - \kappa t + t}\right) = \kappa C_0 \frac{d}{\kappa d + t(1-\kappa)}}$$

24-80 GIVEN: PPC AREA $= A$, SEPARATION $= d$, CAPAC $= C_0$
2 DIELECTRICS κ_1 AND κ_2, $t = \frac{d}{2}$

FIND: E IN EACH DIELECTRIC
ΔV ACROSS PLATES



$$C = \frac{2\kappa_1\kappa_2}{\kappa_1+\kappa_2} C_0$$

$C = \frac{2\kappa_1\kappa_2}{\kappa_1+\kappa_2} C_0$ IS EQUIVALENT TO SERIES CAPACITORS WITH DIELECTRIC κ AND THICKNESS $d/2$

(a) $|\vec{E}| = \frac{\sigma}{\epsilon_0} \Rightarrow E_1 = \frac{\sigma}{\kappa_1\epsilon_0} = \frac{Q}{\kappa_1 A \epsilon_0}$ $\quad E_2 = \frac{\sigma}{\kappa_2\epsilon_0} = \frac{Q}{\kappa_2 A \epsilon_0}$

(b) $\Delta V = |\vec{E}|\, l \Rightarrow \Delta V = E_1 \frac{d}{2} + E_2 \frac{d}{2} = \frac{\sigma}{\kappa_1\epsilon_0}\frac{d}{2} + \frac{\sigma}{\kappa_2\epsilon_0}\frac{d}{2}$

$$= \frac{Qd}{A\kappa_1\epsilon_0 2} + \frac{Qd}{A\kappa_2\epsilon_0 2} = \frac{\kappa_2 Qd + \kappa_1 Qd}{2\kappa_1\kappa_2\epsilon_0 A} = \frac{Qd(\kappa_1+\kappa_2)}{2\kappa_1\kappa_2\epsilon_0 A}$$

(c) $C = \frac{Q}{\Delta V} \Rightarrow C = \frac{\cancel{Q}}{\left[\frac{\cancel{Q}d(\kappa_1+\kappa_2)}{2\kappa_1\kappa_2\epsilon_0 A}\right]} = \frac{2\kappa_1\kappa_2\epsilon_0 A}{(\kappa_1+\kappa_2)d} = \boxed{C_0 \frac{2\kappa_1\kappa_2}{\kappa_1+\kappa_2}}$

(d) $C_1 = \frac{\kappa_1\epsilon_0 A}{d/2}$ $\quad C_2 = \frac{\kappa_2\epsilon_0 A}{d/2}$ $\Rightarrow$

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{d/2}{\kappa_1\epsilon_0 A} + \frac{d/2}{\kappa_2\epsilon_0 A} = \frac{\kappa_2 d + \kappa_1 d}{2\kappa_1\kappa_2\epsilon_0 A}$$

$$C_{eq} = \frac{2\kappa_1\kappa_2\epsilon_0 A}{(\kappa_2+\kappa_1)d} = \boxed{\left(\frac{2\kappa_1\kappa_2}{\kappa_1+\kappa_2}\right)C_0}$$ SAME