Ch. 8 Prob. 49

$V_0 = 500V$ $\quad C_0 = 800pF$

$C_f = 100pF$

How much work is done in turning the dial?

The initial amount of energy is

$$U_0 = \frac{1}{2} C_0 V_0^2 = \frac{1}{2}(800\times10^{-12}F)(500V)^2$$
$$= 1.0\times10^{-4}\,J$$

Charge on the capacitor is

$$C = \frac{Q}{V} \rightarrow Q = C\cdot V = (800\times10^{-12}F)(500V)$$
$$= 4.0\times10^{-7}C$$

When the dial is changed, the charge remains constant since the capacitor is disconnected from the power supply.

After turning the dial, the new voltage across the capacitor is .

$$C = \frac{Q}{V} \rightarrow V_f = \frac{Q}{C_f} = \frac{4.0\times10^{-7}C}{100\times10^{-12}F} = 4000V$$

The new energy on the capacitor is

$$U_f = \frac{1}{2} C_f V_f^2 = \frac{1}{2}(100\times10^{-12}F)(4000V)^2$$
$$= 8.0\times10^{-4}\,J$$

The change in energy is equal to the work done on the capacitor.

$$\Delta U = U_f - U_0 = (8.0\times10^{-4}J) - (1.0\times10^{-4}J) = \boxed{7.0\times10^{-4}J}$$