(a) Because there is no stored energy on the uncharged 4.00-μF capacitor, the total stored energy is

$U_a = \frac{1}{2}C_1V_0^2 = \frac{1}{2}(2.70\times10^{-6}\text{ F})(45.0\text{ V})^2 = \boxed{2.73\times10^{-3}\text{ J.}}$

(b) We find the initial charge on the 2.70-μF capacitor when it is connected to the battery;

$Q = C_1V_0 = (2.70\ \mu\text{F})(45.0\text{ V}) = 121.5\ \mu\text{C}.$

When the capacitors are connected, some charge will flow from C_1 to C_2 until the potential difference across the two capacitors is the same:

$V_1 = V_2 = V.$

Because charge is conserved, we have

$Q = Q_1 + Q_2 = 121.5\ \mu\text{C}.$

For the two capacitors we have

$Q_1 = C_1V$, and $Q_2 = C_2V.$

When we form the ratio, we get

$Q_2/Q_1 = (121.5\ \mu\text{C} - Q_1)/Q_1 = C_2/C_1 = (4.00\ \mu\text{F})/(2.70\ \mu\text{F})$, which gives $Q_1 = 49.0\ \mu\text{C}.$

We find V from

$Q_1 = C_1V;$

$49.0\ \mu\text{C} = (2.70\ \mu\text{F})V$, which gives $V = 18.1$ V.

For the stored energy we have

$U_b = \frac{1}{2}C_1V^2 + \frac{1}{2}C_2V^2 = \frac{1}{2}(C_1 + C_2)V^2 = \frac{1}{2}[(2.70 + 4.00)\times10^{-6}\text{ F}](18.1\text{ V})^2 = \boxed{1.10\times10^{-3}\text{ J.}}$

(c) The change in stored energy is

$\Delta U = U_b - U_a = 1.10\times10^{-3}\text{ J} - 2.73\times10^{-3}\text{ J} = \boxed{-1.63\times10^{-3}\text{ J.}}$

(d) $\boxed{\text{The stored potential energy is not conserved.}}$ During the flow of charge before the final steady state, some of the stored energy is dissipated as thermal and radiant energy.

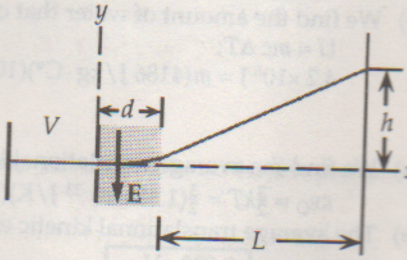
We find the rms speed from

$\text{KE} = \frac{1}{2}mv_{\text{rms}}^2 = \frac{3}{2}kT;$

$(9.11\times10^{-31}\text{ kg})v_{300}^2 = 3(1.38\times10^{-23}\text{ J/K})(300\text{ K})$, which gives $v_{300} = \boxed{1.17\times10^5\text{ m/s.}}$

$(9.11\times10^{-31}\text{ kg})v_{2500}^2 = 3(1.38\times10^{-23}\text{ J/K})(2500\text{ K})$, which gives $v_{2500} = \boxed{3.37\times10^5\text{ m/s.}}$

We find the horizontal velocity of the electron as it enters the electric field from the accelerating voltage:



$\frac{1}{2}mv_0^2 = eV;$

$\frac{1}{2}(9.11\times10^{-31}\text{ kg})v_0^2 = (1.60\times10^{-19}\text{ C})(15\times10^3\text{ V}),$

which gives $v_0 = 7.26\times10^7$ m/s.

Because the force from the electric field is vertical, the horizontal velocity is constant. The time to pass through the field is

$t_1 = d/v_0 = (0.028\text{ m})/(7.26\times10^7\text{ m/s}) = 3.86\times10^{-10}\text{ s}.$

The time for the electron to go from the field to the screen is

$t_2 = L/v_0 = (0.22\text{ m})/(7.26\times10^7\text{ m/s}) = 3.03\times10^{-9}\text{ s}.$

If we neglect the small deflection during the passage through the field, we find the vertical velocity when the electron leaves the field from the vertical displacement:

$v_y = h/t_2 = (0.11\text{ m})/(3.03\times10^{-9}\text{ s}) = 3.63\times10^7\text{ m/s}.$

This velocity was produced by the acceleration in the electric field:

$F = eE = ma_y$, or $a_y = eE/m.$

From the vertical motion in the field, we have

$v_y = v_{0y} + a_yt_1;$

$3.63\times10^7\text{ m/s} = 0 + [(1.60\times10^{-19}\text{ C})E/(9.11\times10^{-31}\text{ kg})](3.86\times10^{-10}\text{ s}),$

which gives $E = \boxed{5.4\times10^5\text{ V/m.}}$