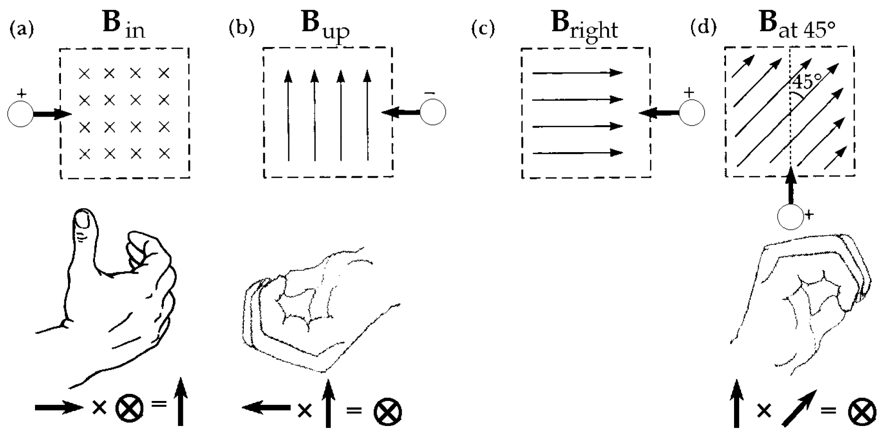
Physics 114 exam 2 solutions

1. (a) up

(b) out of the page, since the charge is negative.

(c) no deflection

(d) into the page



2. The charge stays the same, since it has nowhere to go. E between the plates stays the same since the charge on a parallel-plate capacitor does not depend on the separation, and hence neither does the field. The field outside the paltes remains zero. The potential difference increases, since d increases and E stays the same (V = Ed). The energy increases since E = ½ QV. You need to do work to separate the plates. The capacitance decreases since d is increasing.

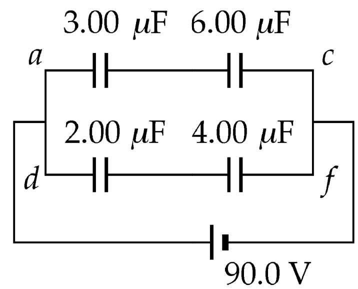
   So we have (a) Stays same. (b) Stays zero. (c) Increases (d) Increases (e) Stays same and (f) Decreases.

3. (a) The bulb goes out. Essentially all the current will go through the wire, where there is no resistance.

   (b) The overall resistance of the circuit decreases, hence the current through A increases and it get brighter.

4. The potential produced by the battery is constant. Resistance is proportional to the length of the resistor. If the length is reduced by a factor of two, the resistance will be reduced by a factor of two. However, (a) the potential difference across the resistor stays the same. An ideal battery always maintains a constant potential difference across its terminals. (b) A smaller resistance with the same applied potential difference leads to a larger current. Note that the resistivity and cross sectional area of the original resistor and one of its halves are the same.

5. (a) $C = \left[\frac{1}{3.00} + \frac{1}{6.00}\right]^{-1} + \left[\frac{1}{2.00} + \frac{1}{4.00}\right]^{-1} = \boxed{3.33\ \mu\text{F}}$



(c) $Q_{ac} = C_{ac}\,(\Delta V_{ac}) = (2.00\ \mu\text{F})(90.0\ \text{V}) = 180\ \mu\text{C}$

Therefore, $Q_3 = Q_6 = \boxed{180\ \mu\text{C}}$

$$Q_{df} = C_{df}\left(\Delta V_{df}\right) = (1.33\ \mu F)(90.0\ \text{V}) = \boxed{120\ \mu\text{C}}$$

(b) $\Delta V_3 = \frac{Q_3}{C_3} = \frac{180\ \mu\text{C}}{3.00\ \mu\text{F}} = \boxed{60.0\ \text{V}}$

$$\Delta V_6 = \frac{Q_6}{C_6} = \frac{180\ \mu\text{C}}{6.00\ \mu\text{F}} = \boxed{30.0\ \text{V}}$$

$$\Delta V_2 = \frac{Q_2}{C_2} = \frac{120\ \mu\text{C}}{2.00\ \mu\text{F}} = \boxed{60.0\ \text{V}}$$

$$\Delta V_4 = \frac{Q_4}{C_4} = \frac{120\ \mu\text{C}}{4.00\ \mu\text{F}} = \boxed{30.0\ \text{V}}$$

(d) $U_T = \frac{1}{2}\,C_{eq}\,(\Delta V)^2 = \frac{1}{2}\,(3.33 \times 10^{-6})(90.0)^2 = \boxed{13.4\ \text{mJ}}$

6. (a) Given $M = \rho_d V = \rho_d A \ell$ where $\rho_d \equiv$ mass density, we obtain: $A = \frac{M}{\rho_d \ell}$

Taking $\rho_r =$ resistivity, $R = \frac{\rho_r \ell}{A} = \frac{\rho_r \ell}{\left(\frac{M}{\rho_d \ell}\right)} = \frac{\rho_r \rho_d \ell^2}{M}$

Thus, $\ell = \sqrt{\frac{MR}{\rho_r \rho_d}} = \sqrt{\frac{\left(1.00 \times 10^{-3}\right)(0.500)}{(1.70 \times 10^{-8})(8.92 \times 10^{3})}} = \boxed{1.82\ \text{m}}$

(b) $V = \frac{M}{\rho_d}$, or $\pi r^2 l = \frac{M}{\rho_d}$

Thus, $r = \sqrt{\frac{M}{\pi \rho_d l}} = \sqrt{\frac{1.00 \times 10^{-3}}{\pi (8.92 \times 10^3)(1.82)}} = 1.40 \times 10^{-4}$ m

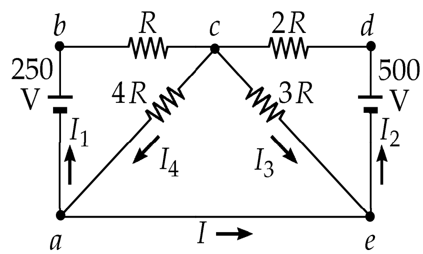
The diameter is twice this distance: $\boxed{\text{diameter} = 280\ \mu\text{m}}$

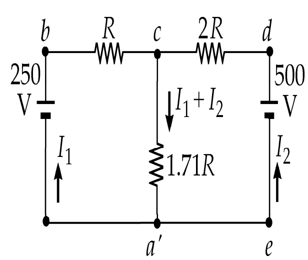
7. a) The 3R and 4R resistors are in parallel. None are in series
   b) The circuit is reduced by combining the two parallel resistors as shown in the second figure.
   c) I already applied the junction rule in the diagram, with I3 = I1 + I2.

Apply Kirchhoff's loop rule to both loops in Figure (b) to obtain:

$(2.71R)I_1 + (1.71R)I_2 = 250$ and $(1.71R)I_1 + (3.71R)I_2 = 500$

with $R = 1000\ \Omega$



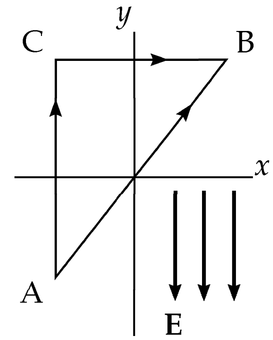


8. (a) $F_B = ILB \sin \theta = (5.00\text{ A})(2.80\text{ m})(0.390\text{ T}) \sin 60.0° = \boxed{4.73\text{ N}}$

(b) $F_B = (5.00\text{ A})(2.80\text{ m})(0.390\text{ T}) \sin 90.0° = \boxed{5.46\text{ N}}$

(c) $F_B = (5.00\text{ A})(2.80\text{ m})(0.390\text{ T}) \sin 120° = \boxed{4.73\text{ N}}$

9. **a)** $V_B - V_A = -\int_A^B \mathbf{E} \cdot d\mathbf{s} = -\int_A^C \mathbf{E} \cdot d\mathbf{s} - \int_C^B \mathbf{E} \cdot d\mathbf{s}$



$V_B - V_A = 325*(0.8)*\cos(180) + 0$

$V_B - V_A = (325)(0.800) = \boxed{+260\text{ V}}$

b) $V_B - V_A = E*d*\cos(\theta) = 325*1.00*(0.8) = 260$ V $[\cos(\theta) = 0.8/1]$