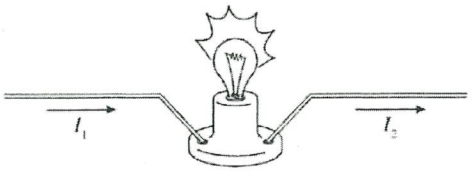
1.

Is I_2 greater than, less than, or equal to I_1? Explain.

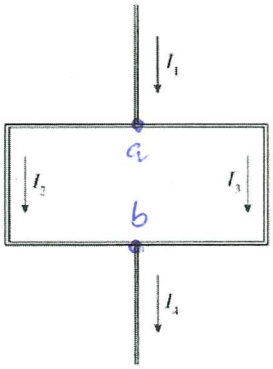


I_1 & I_2 are in series.

$\therefore I_1 = I_2$

2.

All wires in this figure are made of the same material and have the same diameter. Rank in order, from largest to smallest, the currents I_1 to I_4.



Order:

Explanation:

At jcn a $I_1 = I_2 + I_3$

$\therefore I_1 > I_2, I_3$

At jcn b $I_2 + I_3 = I_4$

$\therefore I_4 > I_2, I_3$ and $I_1 = I_4$

since wires are same material & same dimensions,

$I_2 = I_3$. $\therefore \boxed{I_1 = I_4 > I_2 = I_3}$

3.

Metal 1 and metal 2 are each formed into 1-mm-diameter wires. The electric field needed to cause a 1 A current in metal 1 is larger than the electric field needed to cause a 1 A current in metal 2. Which metal has the larger conductivity? Explain.

$J = \sigma E$

$\therefore \frac{I}{A} = \sigma E \Rightarrow \sigma = \frac{I}{AE}$

metal 2 has larger conductivity → requires less $\vec{E}$ to est. the same current.

$I_1 = I_2$

$A_1 = A_2$

$\therefore \frac{\sigma_1}{\sigma_2} = \frac{E_2}{E_1}$ $E_1 > E_2$

$\therefore \sigma_1 < \sigma_2$

4. If a metal is heated, does its conductivity increase, decrease, or stay the same? Explain.

as $T \uparrow$, $\sigma \downarrow$.

As temp. increases, get increased thermal vibrations of pos. ions in the metal. This reduces the avg. time τ between e^- scattering events. $\therefore v_d \downarrow$ ~~$\uparrow$~~ ~~$\sigma = n_e e v_d \downarrow$~~

$\sigma = \frac{e^2 n_e \tau}{m} \downarrow$

5. Wire 1 and wire 2 are made from the same metal. Wire 2 has a larger diameter than wire 1. The electric field strengths E_1 and E_2 in the wires are equal.

a. Compare the values of the two current densities. Is J_1 greater than, less than, or equal to J_2? Explain.

$J = \sigma E$ same metal $\therefore \sigma_1 = \sigma_2$, same E $\therefore E_1 = E_2$

$\therefore J_1 = J_2$

b. Compare the values of the currents I_1 and I_2.

$I = JA$ $A_2 > A_1$ $\therefore I_2 > I_1$

c. Compare the values of the electron drift speeds $(v_d)_1$ and $(v_d)_2$.

$v_d = \frac{eE}{m}\tau$ $\tau_1 = \tau_2$ (same material)

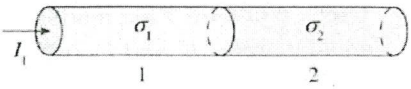
$E_1 = E_2$ $\therefore v_{d,1} = v_{d,2}$

Alternatively, $J = e n_e v_d$

since $J_1 = J_2$, $v_{d,1} = v_{d,2}$

6.

A wire consists of two equal-diameter segments. Their conductivities differ, with $\sigma_2 > \sigma_1$. The current in segment 1 is I_1.



a. Compare the values of the currents in the two segments. Is I_2 greater than, less than, or equal to I_1? Explain.

$I_1 = I_2$ the segments are in series.

b. Compare the strengths of the current densities J_1 and J_2.

$J_1 = J_2$ $\quad J = \frac{I}{A}$ & $I_1 = I_2$, $A_1 = A_2$

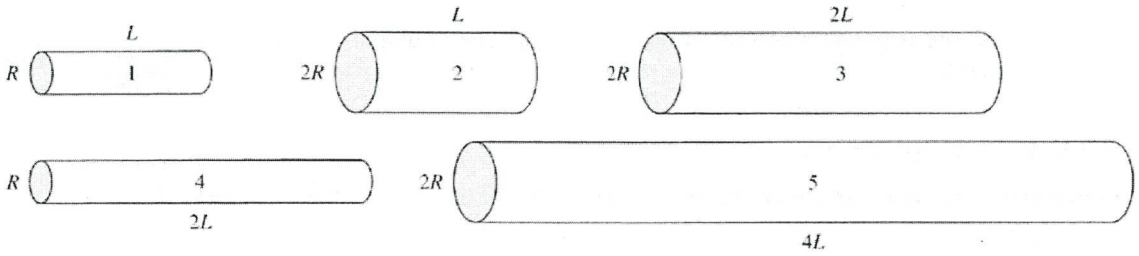
c. Compare the strengths of the electric fields E_1 and E_2 in the two segments.

$J = \sigma E \quad \therefore E = \frac{J}{\sigma} \quad \therefore \frac{E_1}{E_2} = \frac{\sigma_2}{\sigma_1}$

since $\sigma_2 > \sigma_1$, $E_1 > E_2$

7.

The wires below are all made of the same material. Rank in order, from largest to smallest, the resistances R_1 to R_5 of these wires.



Order:

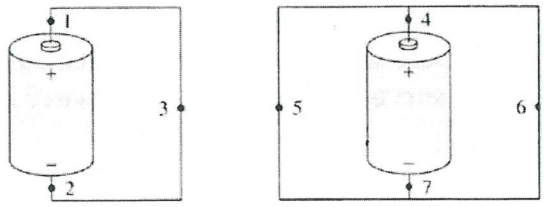
Explanation: $R = \rho \frac{l}{A} = \rho \frac{l}{\pi r^2} \therefore R \propto \frac{l}{r^2}$

$R_1 = \frac{L}{R^2}$ $\quad R_2 = \frac{L}{4R^2}$ $\quad R_3 = \frac{L}{2R^2}$ $\quad R_4 = \frac{2L}{R^2}$ $\quad R_5 = \frac{L}{R^2}$

$R_4 > R_1 = R_5 > R_3 > R_2$

8.

The two circuits use identical batteries and wires of equal diameters. Rank in order, from largest to smallest, the currents I_1 to I_7 at points 1 to 7.



Order: $I_1 = I_2 = I_3$ (series)

Explanation: $I_4 = I_7$ (series)

wires 5 & 6 have same geometry $\therefore R_5 = R_6 \Rightarrow I_5 = I_6$

if wire 3 has resistance R, wires 5 & 6 also have resistance R

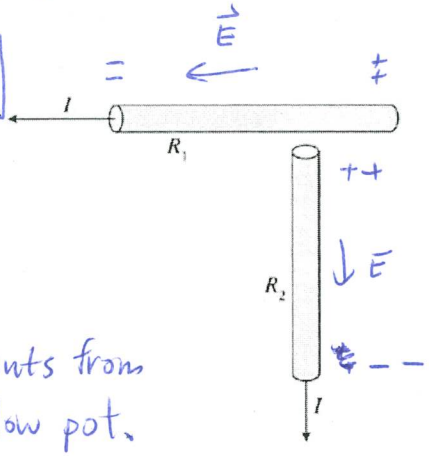
$\therefore I_3 = I_5 = I_6$ (same ΔV, same R)

$I_4 = I_5 + I_6$ (junct. rule) $\therefore I_4 > I_5, I_6$

$\therefore$ $\boxed{I_4 = I_7 > I_1 = I_2 = I_3 = I_5 = I_6}$

9.

For resistors R_1 to R_2:



a. Which end (left, right, top, or bottom) is more positive?

R_1: right R_2: top

b. In which direction (such as left to right or top to bottom) does the potential decrease?

R_1: right to left

R_2: top to btm.

$\vec{E}$ ~~not~~ points from high to low pot.

10.

Wire 1 and wire 2 are made from the same metal. Wire 1 has twice the diameter and half the electric field of wire 2. What is the ratio I_1/I_2?

$I = JA = \sigma E A$ $\sigma_1 = \sigma_2$ (same material)

$\therefore \frac{I_1}{I_2} = \frac{E_1 A_1}{E_2 A_2} = \frac{E_1}{E_2}\left(\frac{d_1}{d_2}\right)^2$ $A \propto d^2$

$= \frac{1}{2}(2)^2 = 2$ $\boxed{\therefore I_1 = 2I_2}$