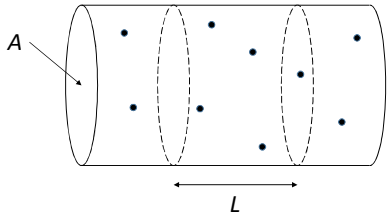
Consider the following four situations.

i) An ion (charge +Q) moves to the right.
ii) A neutral hydrogen atom (proton, +e, and electron, -e) moves right.
iii) A beam of electrons in a TV shoots right
iv) In an ionic solution, massive positive ions flow right, electrons flow with equal speed left.

In which is the *net* current to the right?

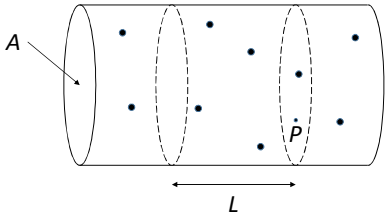
A) i only
B) iii only
C) iv only
D) i and iv only
E) none of these

In terms of the quantities in the figure, the *number density* (*n*) of charge carriers, and the *charge per carrier* (*q*), how much charge is enclosed in the volume bounded by the dashed lines?



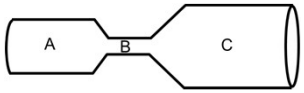
A) nAL
B) ALq
C) nAq/L
D) $nALq$
E) none of these

In terms of the quantities in the figure and the *drift velocity* (v_d), how much time does it take for the charge enclosed in the dashed lines to pass by point *P*?



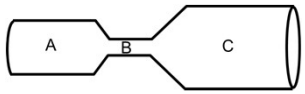
A) L/v_d
B) Lv_d
C) AL/v_d
D) ALv_d
E) none of these

A copper cylinder is machined to have the following shape. The ends are connected to a battery so that a current flows through the copper. Which region has the greatest magnitude of current (*I*)?



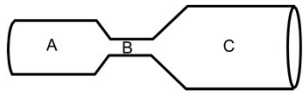
A) A
B) B
C) C
D) all three are the same
E) not enough info

A copper cylinder is machined to have the following shape. The ends are connected to a battery so that a current flows through the copper. Which region has the greatest magnitude of current density ($|\vec{J}|$)?



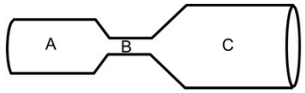
A) A
B) B
C) C
D) all three are the same
E) not enough info

A copper cylinder is machined to have the following shape. The ends are connected to a battery so that a current flows through the copper. Which region has the greatest conductivity (σ)?



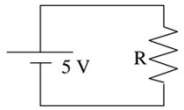
A) A
B) B
C) C
D) all three are the same
E) not enough info

A copper cylinder is machined to have the following shape. The ends are connected to a battery so that a current flows through the copper. Which region has the greatest magnitude electric field ($|\vec{E}|$)?



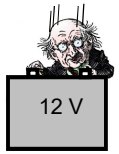
A) A
B) B
C) C
D) all three are the same
E) not enough info

In the circuit shown, a current "*I*" flows. If we double the voltage of the battery what happens to the resistance of the resistor?



A) R doubles
B) R halves
C) R stays the same

Your (slightly crazed) physics professor wants to grab both poles of a regular 12 V car battery. What will happen?



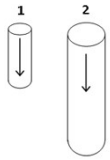
A) STOP! Don't let him do it, this is dangerous!

B) Warning! This is going to hurt a little.

C) Let him go for it. He won't notice a thing…

D) I abstain from voting

Two cylindrical resistors are made of the same material (same resistivity ρ). The arrow shows the direction of current flow. Resistor 2 is twice as long and has twice the diameter of resistor 1. What is the ratio $\frac{R_2}{R_1}$?



A) 2

B) 4

C) ½

D) ¼

E) 1

A copper wire and an aluminum wire both have the same dimensions (same length, same cross-sectional area). Which one statement is true?

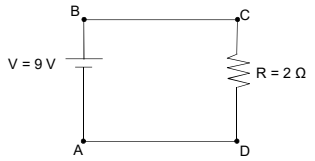
A) Both wires have the same resistance R and the same resistivity ρ.

B) The wires have different R and different ρ.

C) The wires have the same R but different ρ.

D) The wires have different R but the same ρ.

A 9 volt battery is attached to a 2 Ω resistor by ideal wires. The circuit diagram is shown below. Suppose the potential at point A is $V_A = 0$ V. The potentials at the points B, C, and D are…



A) $V_B = 0$ V, $V_C = 9$ V, $V_D = 0$ V

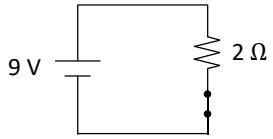
B) $V_B = 9$ V, $V_C < 9$ V, $V_D > 0$ V

C) $V_B = 9$ V, $V_C < 9$ V, $V_D = 0$ V

D) $V_B = 9$ V, $V_C = 9$ V, $V_D = 0$ V

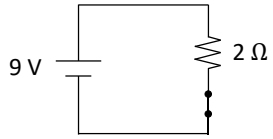
E) None of these

In the circuit shown, the switch is closed. The electric potential difference, ΔV across the resistor (from its "bottom" to its "top") is…



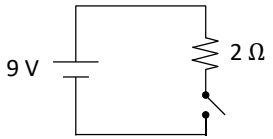
A) 0 V
B) 4.5 V
C) 9 V
D) 18 V
E) None of these

In the circuit shown, the switch is closed. The current flowing through the resistor is…



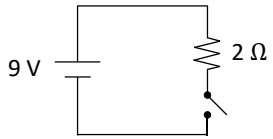
A) 2 A
B) 4.5 A
C) 9 A
D) 18 A
E) None of these

In the circuit shown, the switch is open. The electric potential difference, ΔV across the resistor (from its "bottom" to its "top") is…



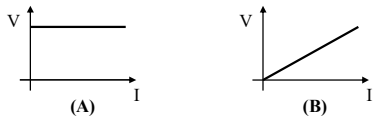
A) 0 V
B) 4.5 V
C) 9 V
D) 18 V
E) None of these

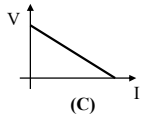
In the circuit shown, the switch is open. The electric potential difference, ΔV across the switch is…

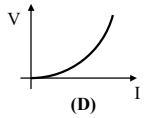


A) 0 V
B) 4.5 V
C) 9 V
D) 18 V
E) None of these

Which graph of voltage vs. current shows the behavior of an "ohmic" resistor (a resistor obeying Ohm's Law).

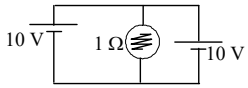






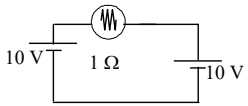
(E) None of these

What is the current through the resistor?



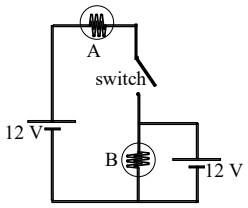
A) 0 A
B) 1 A
C) 2 A
D) 10 A
E) 20 A

What is the current through the resistor?



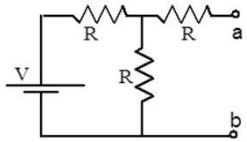
A) 0 A
B) 1 A
C) 2 A
D) 10 A
E) 20 A

Notice that A is currently dark and B is currently glowing (do you understand why?). Now, the switch is about to be to closed. What will happen to the (identical) bulbs?



A) A glows, B changes
B) A glows, B stays the same
C) A stays dark, B changes
D) A stays dark, B stays the same

Points a and b aren't connected to anything. What is the potential difference between points a and b?



A) V/2

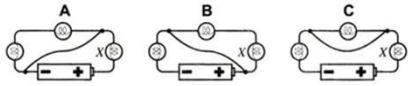
B) V/3

C) V/4

D) zero

E) V

How many following statements is/are true about the following circuits? Assume all batteries and all bulbs are identical.



i. Bulb A does not turn on, because the potential difference across it is zero.
ii. Bulb B does not turn on, because the potential difference across it is zero.
iii. Bulb C does not turn on, because the potential difference across it is zero.

A) all three are true

B) only i) is true

C) only ii) is true

D) only iii) is true

A 60W light bulb and a 100W light bulb each has a filament with a certain resistance (when the bulb is on and hot). How do the resistances of the filaments compare? [Hint: When a light bulb is plugged in, it is essentially attached to a battery with constant voltage.]

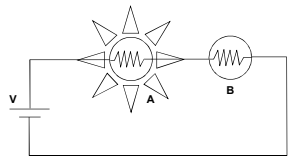
A) $R_{60\,W} = R_{100\,W}$

B) $R_{60\,W} > R_{100\,W}$

C) $R_{60\,W} < R_{100\,W}$

D) Impossible to tell without further information

Two light bulbs, A and B, are in series, so they carry the same current. Light bulb A is brighter than B. Which bulb has higher resistance? (HINT: brighter means more power.)

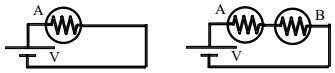


A) A

B) B

C) Same resistance

We start with the left circuit with bulb (A). If we add a second bulb (B) as shown on the right, what happens to bulb A?

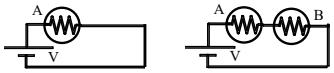


A) Bulb A is equally bright

B) Bulb A is dimmer than before

C) Bulb A is brighter than before

We start with the left circuit with bulb (A). If we add a second bulb (B) as shown on the right, what happens to the power supplied by the battery?



A) The power supplied by the battery increases

B) The power supplied by the battery decreases

C) The power supplied by the battery remains the same

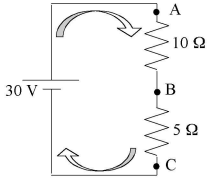
Which has higher resistance? [Note: Assume the wattage label of a bulb assumes that the bulb will be connected (by itself) to a 120 V battery.]

A) 100 W bulb

B) 60 W bulb

C) Same R in both

What is the current through the 10 Ω resistor?



A) 1 A

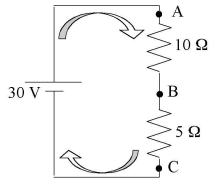
B) 2 A

C) 3 A

D) 5 A

E) 6 A

What is the voltage drop across the 10 Ω resistor?



A) 30 V

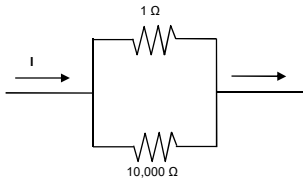
B) 20 V

C) 15 V

D) 10 V

E) 0 V

A 1 Ω resistor is placed in parallel with a 10,000 Ω resistor as shown. The total, equivalent resistance of these two resistors in parallel is closest to…



A) a little less than 1 Ω

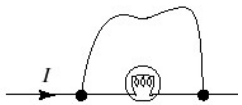
B) a little more than 1 Ω

C) 5000 Ω

D) a little less than 10000 Ω

E) a little more than 10000 Ω

Current flows through a light bulb. Suppose a wire is connected across the bulb as shown. When this wire (assumed to be ideal) is connected…

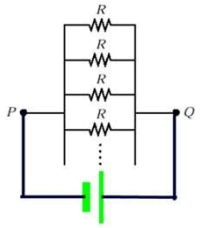


A) All the current continues to flow through the bulb

B) Half the current flows throughthe bulb, half through the wire

C) All the current flows through the wire

Points P and Q are connected to a battery of fixed voltage. As more resistors R are added to the parallel circuit, what happens to the current passing **through the battery**?



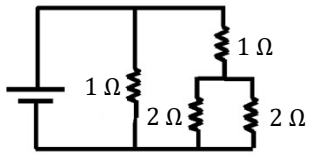
A) increases

B) decreases

C) stays the same

D) drops to zero

Consider the circuit below. What is the total resistance which the battery sees?



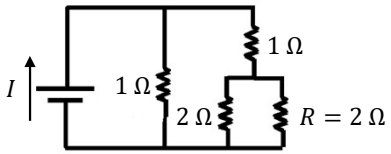
A) 1 Ω

B) 2 Ω

C) 0.5 Ω

D) 0.25 Ω

Consider the circuit below. If the resistor R is increased from $2\ \Omega$ to $5\ \Omega$ what will happen to the current I through the battery?



A) I increases

B) I decreases

C) I remains constant

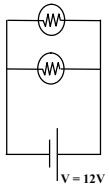
When I screw in the parallel bulb, the bulb that's already there will…

A) get brighter

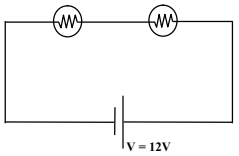
B) get dimmer

C) remain the same brightness

The four light bulbs shown are identical. Which circuit puts out more total light (from both bulbs combined)? (Hint: more power = more light).



Circuit A



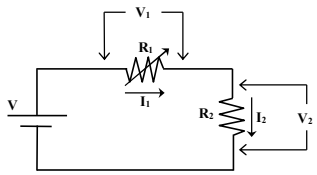
Circuit B

A) A

B) B

C) They both put out the same amount of light

The circuit below consists of a battery attached to two resistors in series. Resistor R_1 is ***variable***. When R_1 is decreased, the voltage V_2 across R_2…

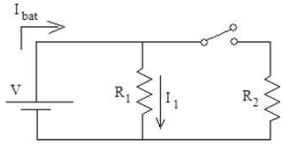


A) increases

B) decreases

C) stays the same

Consider the circuit shown, with the switch initially open. When the switch is closed, the current I_1 through resistor R_1…

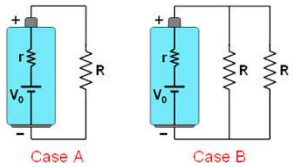


A) increases.

B) decreases.

C) remains the same.

The 'real' batteries and the resistors in both cases illustrated above are identical. In which case is the voltage across the terminals of the battery closest to the ideal battery voltage V_0?

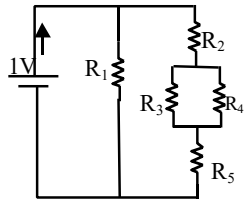


A) Terminal voltage is closer to V_0 in Case A

B) Terminal voltage is closer to V_0 in Case B

C) Terminal voltage is the same in Cases A and B

In the circuit below, which resistors must have the same current flowing through them? Do not assume that the resistors are identical.



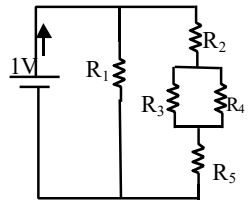
A) R_2/R_5 only

B) R_3/R_4 only

C) R_2/R_5 and R_3/R_4

D) $R_1/R_2/R_5$ only

Which resistors must have the same voltage drop across them?



A) R_2/R_5 only

B) R_3/R_4 only

C) R_2/R_5 and R_3/R_4

D) $R_1/R_2/R_5$ only