Worksheet: Resistance and Resitivity of Conductors

Q1: A wire made of an unknown substance has a resistance of 125 mΩ. The wire has a length of 1.8 m and a cross-sectional area of 2.35×10^{-5} m^2. What is the resistivity of the substance from which the wire ismade?

A 5.3×10^{-6} $\Omega \cdot \text{m}$

B 1.6×10^{-3} $\Omega \cdot \text{m}$

C 1.6×10^{-6} $\Omega \cdot \text{m}$

D 9.6×10^{6} $\Omega \cdot \text{m}$

E 9.6×10^{3} $\Omega \cdot \text{m}$

Q2: A copper wire with a resistance of 12.8 mΩ has a cross-sectional area of 1.15×10^{-5} m. Find the length of the wire. Use 1.7×10^{-8} $\Omega \cdot \text{m}$ for the resistivity of copper.

A 8.7×10^{6} m

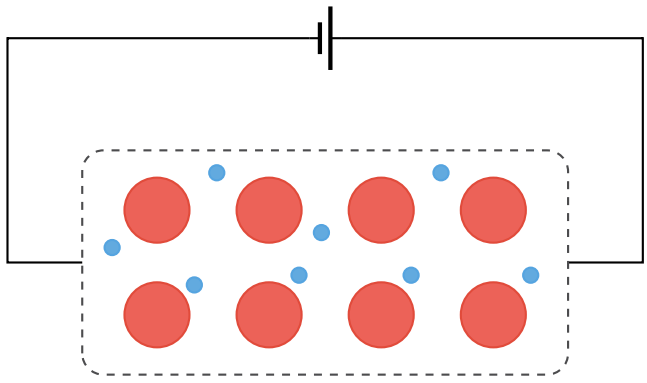
B 8.7 m

C 0.12 m

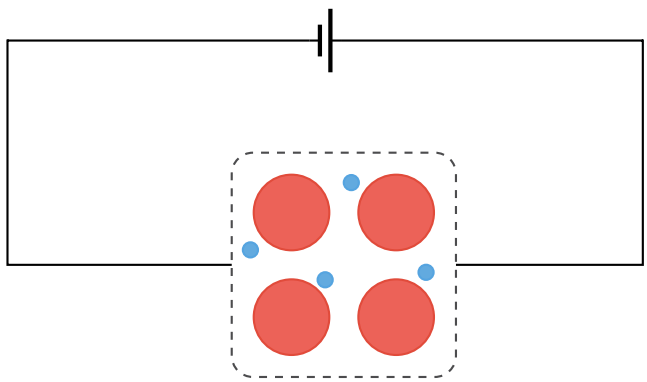
D 8.7×10^{3} m

E 120 m

Q3: The diagram shows two identical circuits. Each circuit'sconducting wire has had a section of it greatly magnified to show the ions thatthe conducting wire is comprised of and the free electrons that move betweenthese ions. The conducting wires are both made of the same substance.



(a)



(b)

Which of the following statements correctly states how the resistivities of the sections of conducting wirein diagram (a) and diagram (b) compare to each other?

A The resistivity of the section in diagram (a) is greater than the resistivity of the section in diagram (b).

B The resistivities are the same for both sections.

C The resistivity of the section in diagram (b) is greater than the resistivity of the section in diagram (a).

Which of the following statements correctly states how the cross-sectional areas of the conducting wirescompare to each other?

A The cross-sectional area of the wire in diagram (a) is greater than the cross-sectional area of the wire in diagram (b).

B The cross-sectional areas of the wires are the same.

C The cross-sectional area of the wire in diagram (b) is greater than the cross-sectional area of the wire in diagram (a).

Which of the following statements correctly states how the average time taken for a free electron to crossfrom one side of the section to the other side in diagram (a) compares to theaverage time taken for a free electron to cross from one side of the section tothe other side in diagram (b)?

A The time taken for the section in diagram (b) is greater.

B The time taken for the section in diagram (a) is greater.

C The time taken is the same for both sections.

Which of the following statements correctly states how the resistance of the section of conducting wire indiagram (a) compares to the resistance of the section of conducting wire indiagram (b)?

A The resistance of the section in diagram (b) is greater.

B The resistance of the section in diagram (a) is greater.

C The resistance is the same for both sections.

Q4: The wires that carry current from a power station to asubstation are 7.25 km long. They are made of copper with a resistivity of $1.7 \times 10^{-8}\ \Omega \cdot \text{m}$. The current through the wires is 450 mA. The powerdissipated by the wires is required to be no more than 15 W. What is theminimum cross-sectional area required for the wires that transmit the current?

A $8.2 \times 10^{-6}\ \text{m}^2$

B $1.7 \times 10^{-9}\ \text{m}^2$

C $3.7 \times 10^{-9}\ \text{m}^2$

D $1.7 \times 10^{-6}\ \text{m}^2$

E $3.7 \times 10^{-6}\ \text{m}^2$

Q5: Which of the following formulas correctly relates the resistivity, ρ, of a substance to the resistance of an object with a length, l, that is made of the substance if the object has across-sectional area A and aresistance R?

A $R = \frac{\rho A}{l}$

B $R = \rho A l$

C $\rho = \frac{Rl}{A}$

D $R = \frac{\rho l}{A}$

Q6: A copper wire with a resistance of 22 mΩ has a length of 6.2 m. Find the cross-sectional area. Use 1.7×10^{-8} Ω·m for the resistivity of copper.

A 4.8×10^{-6} m^2

B 2.3×10^{-3} m^2

C 8.0×10^{-4} m^2

D 2.1×10^{-5} m^2

E 7.5×10^{-6} m^2

Q7: A current of 1.4 A in a copper wire is carried by free electrons. The cross-sectional area of the wire is 2.5×10^{-6} m^2. Find the average speed at which free electrons pass through the wire. Use a value of 1.6×10^{-19} C for electron charge and a value of 8.46×10^{28} m^{-3} for the density of freeelectrons in copper.

A 4.1×10^{-5} m/s

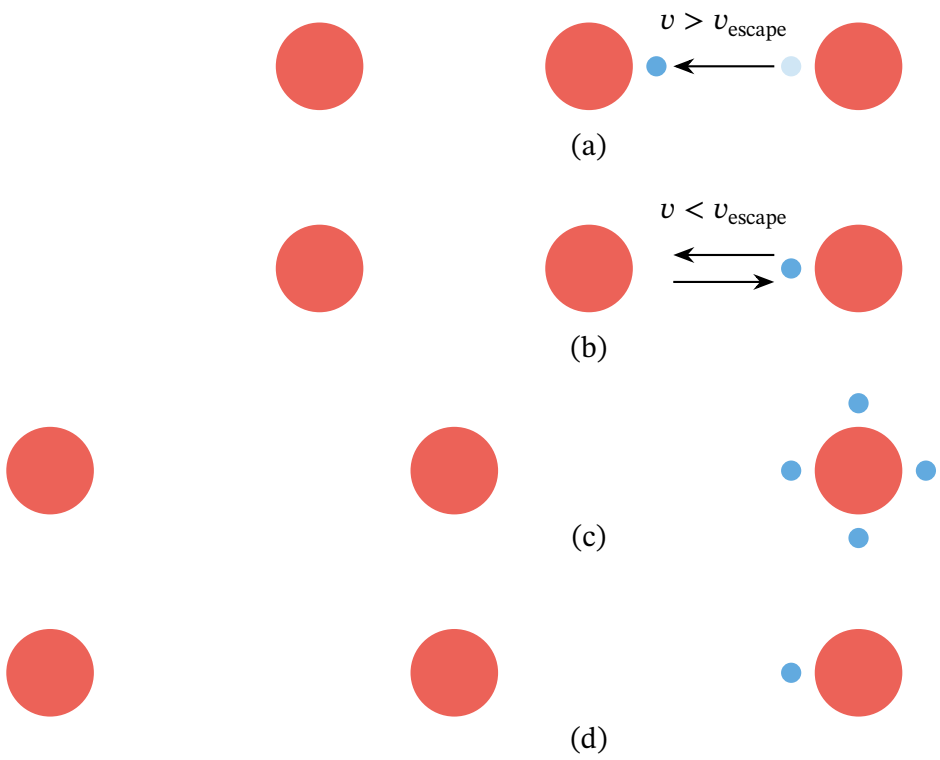
B 4.7×10^{4} m/s

C 2.4×10^{4} m/s

D 5.3×10^{-5} m/s

E 2.1×10^{-5} m/s

Q8: Diagrams (a) and (b) show sections of identicalconducting objects consisting of three equally separated ions. Free electronsthat have a velocity greater than a velocity v_{escape} move away fromthe nearest ion to a neighboring ion. Free electrons with velocities lowerthan v_{escape} do not move to a neighboring ion. Diagrams (c) and (d) show sections of conducting objects in which the spacing between ions is greater than it is for the objects shown in diagrams (a) and (b). The density of free electrons in the object in diagram (d) is the same as the free electron density in the objects shown in diagrams (a) and (b). The density of free electrons in the object in diagram (c) is greater than the free electron density in the objects shown in diagrams (a) and (b). The average speed at which a single typical electron moves in the objects in diagrams (c) and (d) is v_{escape}.



Identical-sized wires made of the materials that the objects in diagrams (a) and (d) are made of are connected across the same potential difference. Which of the following statements most correctly describes how the current through wire I, which is made of the material from diagram (a), compares to the current through wire II, which is made of the material from diagram (d)?

A The current is the same in both wires.

B The current in wire II is greater than the current in wire I.

C The current in wire I is greater than the current in wire II.

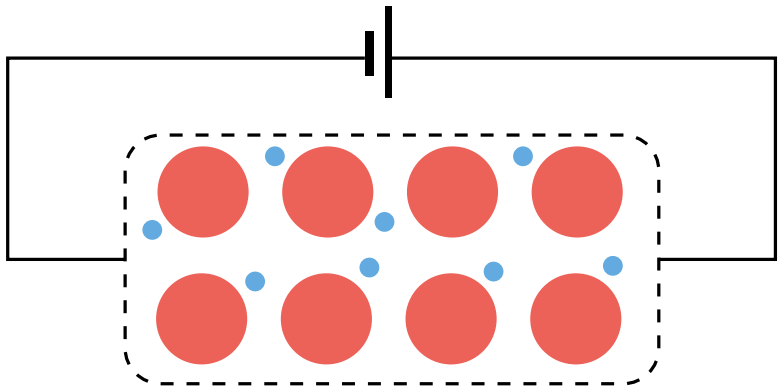
Identical-sized wires made of the materials that the objects in diagrams (c) and (d) are made of are connected across the same potential difference. Which of the following statements most correctly describes how the current through wire I, which is made of the material from diagram (c), compares to the current through wire II, which is made of the material from diagram (d)? Take into account the mutual repulsion of electrons.

A The current is the same in both wires.

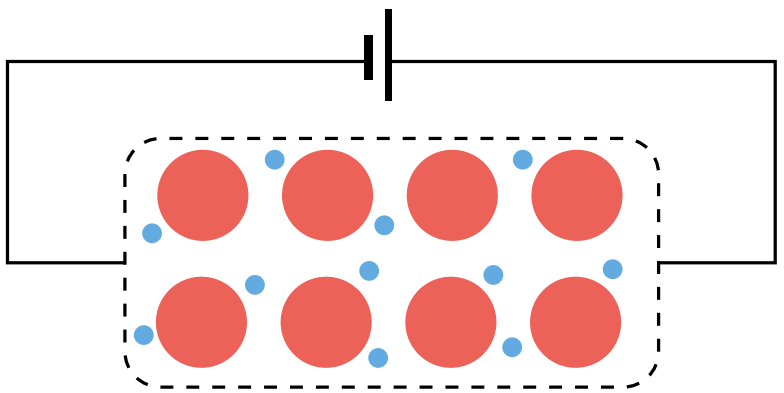
B The current in wire II is greater than the current in wire I.

C The current in wire I is greater than the current in wire II.

Q9: The diagram shows two very similar circuits. Each circuit'sconducting wire has had a section of it greatly magnified to show the ions thatthe conducting wire is comprised of and the free electrons that move betweenthese ions.



(a)



(b)

Which of the following statements correctly states how the resistivities of the sections of the conducting wire in diagram (a) and diagram (b) compare to each other?

A The resistivity of both sections is the same.

B The resistivity of the section in diagram (a) is greater.

C The resistivity of the section in diagram (b) is greater.

Which of the following statements correctly states how the cross-sectional areas of the conducting wires compare to each other?

A The cross-sectional area of the wire in diagram (b) is greater than the cross-sectional area of the wire in diagram (a).

B The cross-sectional areas of the wires are the same.

C The cross-sectional area of the wire in diagram (a) is greater than the cross-sectional area of the wire in diagram (b).

Which of the following statements correctly states how the number of free electrons per meter of length of the conducting wire in diagram (a) compares to the number of free electrons per meter of length of the conducting wire in diagram (b)?

A The number of free electrons per meter of length is the same for both wires.

B The number of free electrons per meter of length of the conducting wire in diagram (b) is greater than the number of free electrons per meter of length of the conducting wire in diagram (a).

C The number of free electrons per meter of length of the conducting wire in diagram (a) is greater than the number of free electrons per meter of length of the conducting wire in diagram (b).

Which of the following statements correctly states how the average time taken for a free electron to cross from one side of the section to the other side in diagram (a) compares to the average time taken for a free electron to cross from one side of the section to the other side in diagram (b)?

A The average time taken for a free electron to cross from one side of the section to the other side in diagram (b) is greater than the average time taken for a free electron to cross from one side of the section to the other side in diagram (a).

B The average time taken for a free electron to cross from one side of the section to the other side is the same for both sections.

C The average time taken for a free electron to cross from one side of the section to the other side in diagram (a) is greater than the average time taken for a free electron to cross from one side of the section to the other side in diagram (b).

Which of the following statements correctly states how the resistance of the section of conducting wire in diagram (a) compares to the resistance of the section of conducting wire in diagram (b)?

A The resistance of both sections is the same.

B The resistance of the section in diagram (a) is greater.

C The resistance of the section in diagram (b) is greater.

Q10: A current of 77 mA in a conducting wire of an unknownmaterial is carried by free electrons. The cross-sectional area of theconductor is $1.5 \times 10^{-6}\ \mathrm{m}^2$. Find the density of freeelectrons in the material if the average speed of the free electrons along the wireis 0.18 mm/s. Use a value of 1.6×10^{-19} C for the electron charge.

A $1.8 \times 10^{27}\ \mathrm{m}^{-3}$

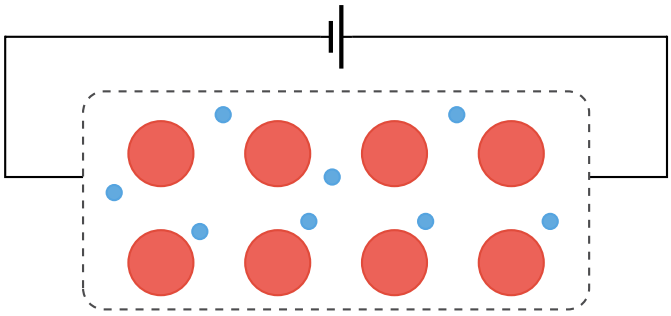
B $3.0 \times 10^{29}\ \mathrm{m}^{-3}$

C $1.8 \times 10^{24}\ \mathrm{m}^{-3}$

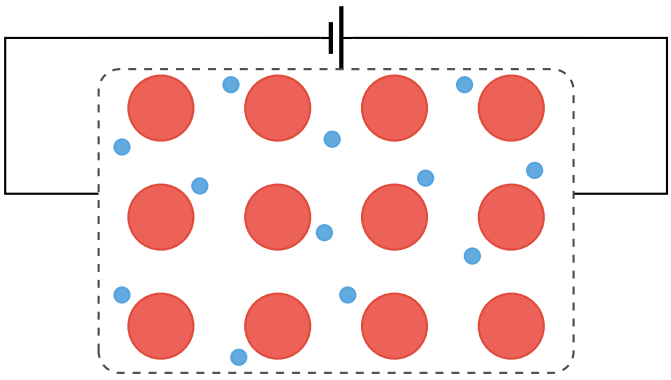
D $1.8 \times 10^{30}\ \mathrm{m}^{-3}$

E $3.0 \times 10^{26}\ \mathrm{m}^{3}$

Q11: The diagram shows two very similar circuits. Each circuit'sconducting wire has had a section of it greatly magnified to show the ions thatthe conducting wire is comprised of and the free electrons that move betweenthese ions. The conducting wires are both made of the same substance, but theconducting wires in the circuit in diagram (b) are of greater thickness thanthe conducting wires in the circuit in diagram (a).



(a)



(b)

Which of the following statements correctly states how the resistivities of the sections of the conducting wires in diagram (a) and diagram (b) compare to each other?

A The resistivities are the same for both sections.

B The resistivity of the section in diagram (b) is greater than the resistivity of the section in diagram (a).

C The resistivity of the section in diagram (a) is greater than the resistivity of the section in diagram (b).

Which of the following statements correctly states how the cross-sectional areas of the conducting wires compare to each other?

A The cross-sectional area of the wire in diagram (b) is greater than the cross-sectional area of the wire in diagram (a).

B The cross-sectional areas of the wires are the same.

C The cross-sectional area of the wire in diagram (a) is greater than the cross-sectional area of the wire in diagram (b).

Which of the following statements correctly states how the number of free electrons per meter of length ofthe conducting wire in diagram (a) compares to the number of free electrons permeter of length of the conducting wire in diagram (b)?

A The number of free electrons per meter of length of the conducting wire in diagram (b) is greater than the number of free electrons per meter of length of the conducting wire in diagram (a).

B The number of free electrons per meter of length is the same for both wires.

C The number of free electrons per meter of length of the conducting wire in diagram (a) is greater than the number of free electrons per meter of length of the conducting wire in diagram (b).

Which of the following statements correctly states how the average time taken for a free electron to crossfrom one side of the section to the other side in diagram (a) compares to theaverage time taken for a free electron to cross from one side of the section tothe other side in diagram (b)?

A The average time taken for a free electron to cross from one side of the section to the other side is the same for both sections.

B The average time taken for a free electron to cross from one side of the section to the other side in diagram (b) is greater than the average time taken for a free electron to cross from one side of the section to the other side in diagram (a).

C The average time taken for a free electron to cross from one side of the section to the other side in diagram (a) is greater than the average time taken for a free electron to cross from one side of the section to the other side in diagram (b).

Which of the following statements correctly states how the resistance of the section of the conducting wire in diagram (a) compares to the resistance of the section of the conducting wire in diagram (b)?

A The resistance of the section in diagram (a) is greater.

B The resistance of both sections is the same.

C The resistance of the section in diagram (b) is greater.