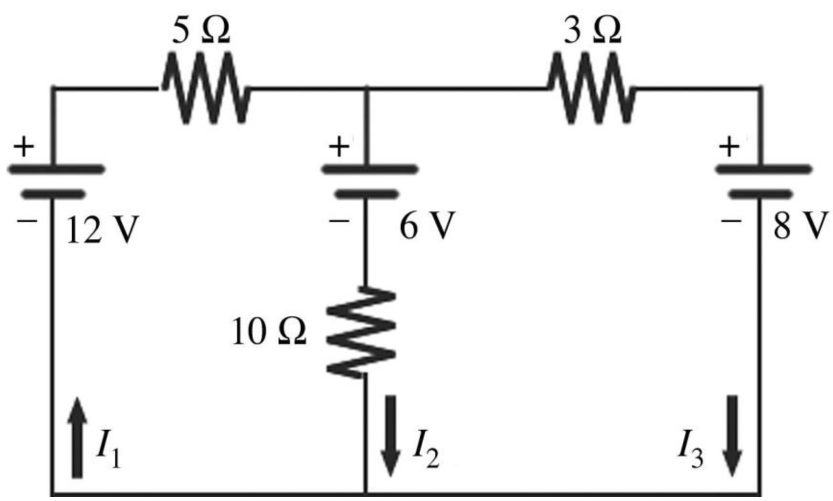
PHYS 1220 Mid-Term Exam 2 November 3rd, 2016

1) An electron moving in the direction of the +*x*-axis enters a magnetic field. If the electron experiences a magnetic deflection in the -*y* direction, the direction of the magnetic field in this region points in the direction of the

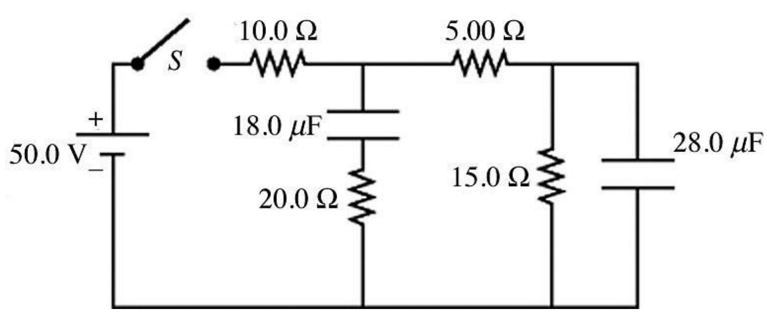
A) -*y*-axis. B) +*z*-axis. C) +*y*-axis. D) -*z*-axis. E) -*x*-axis.

2) For the circuit shown in the figure, all quantities are accurate to 2 significant figures. What is the value of the current I_1?



A) 0.89 A B) 0.32 A C) 0.11 A D) 0.61 A E) 0.29 A

3) For the circuit shown in the figure, the capacitors are all initially uncharged, the connecting leads have no resistance, the battery has no appreciable internal resistance, and the switch *S* is originally open.



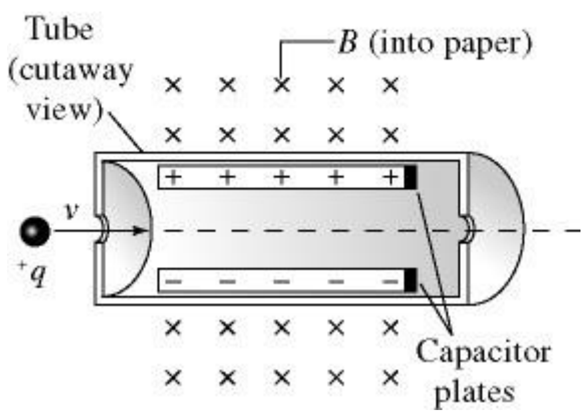
After the switch *S* has been closed for a very long time, what is the potential difference across the 28.0-μF capacitor?

A) 0.00 V B) 25.0 V C) 3.33 V D) 37.5 V E) 50.0 V

4) You are given a copper bar of dimensions 3 cm × 5 cm × 8 cm and asked to attach leads to it in order to make a resistor. If you want to achieve the SMALLEST possible resistance, you should attach the leads to the opposite faces that measure

A) 3 cm × 5 cm.
B) 3 cm × 8 cm.
C) 5 cm × 8 cm.
D) Any pair of faces produces the same resistance.

5) The figure shows a velocity selector that can be used to measure the speed of a charged particle. A beam of particles is directed along the axis of the instrument. A parallel plate capacitor sets up an electric field *E*, which is oriented perpendicular to a uniform magnetic field *B*. If the plates are separated by 2.0 mm and the value of the magnetic field is 0.60 T, what voltage between the plates will allow particles of speed 5.0×10^5 m/s to pass straight through without deflection?

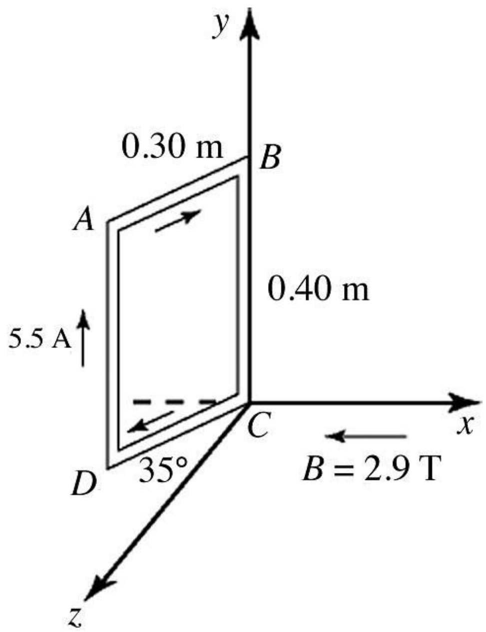


A) 1900 V B) 190 V C) 94 V D) 3800 V E) 600 V

6) Nichrome wire, often used for heating elements, has resistivity of 1.0×10^{-6} Ω • m at room temperature. What length of No. 30 wire (of diameter 0.250 mm) is needed to wind a resistor that has 50 ohms at room temperature?

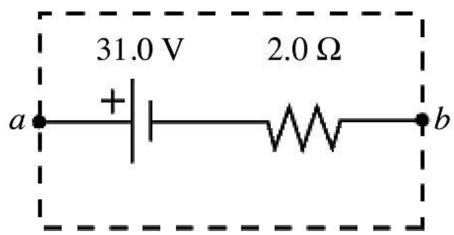
A) 22.4 m B) 0.61 m C) 3.66 m D) 6.54 m E) 2.45 m

7) A rigid rectangular loop, which measures 0.30 m by 0.40 m, carries a current of 5.5 A, as shown in the figure. A uniform external magnetic field of magnitude 2.9 T in the negative *x* direction is present. Segment *CD* is in the *xz*-plane and forms a 35° angle with the *z*-axis, as shown. Find the magnitude of the external torque needed to keep the loop in static equilibrium.



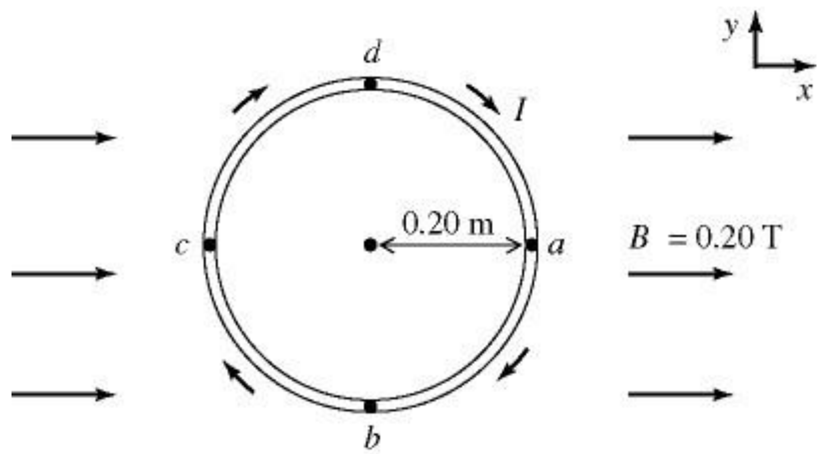
A) 1.1 N • m B) 1.4 N • m C) 1.6 N • m D) 0.73 N • m E) 1.3 N • m

8) The emf and the internal resistance of a battery are as shown in the figure. When the terminal voltage V_{ab} is equal to 17.4 V, what is the current through the battery, including its direction?



A) 8.7 A, from *b* to *a*
B) 6.8 A, from *b* to *a*
C) 16 A, from *b* to *a*
D) 6.8 A, from *a* to *b*
E) 8.7 A, from *a* to *b*

9) A rigid circular loop has a radius of 0.20 m and is in the *xy*-plane. A clockwise current *I* is carried by the loop, as shown. The magnitude of the magnetic moment of the loop is 0.75 A-m^2. A uniform external magnetic field, B = 0.20 T in the positive *x*-direction, is present. An external torque changes the orientation of the loop from one of lowest potential energy to one of highest potential energy. The work done by this external torque is closest to

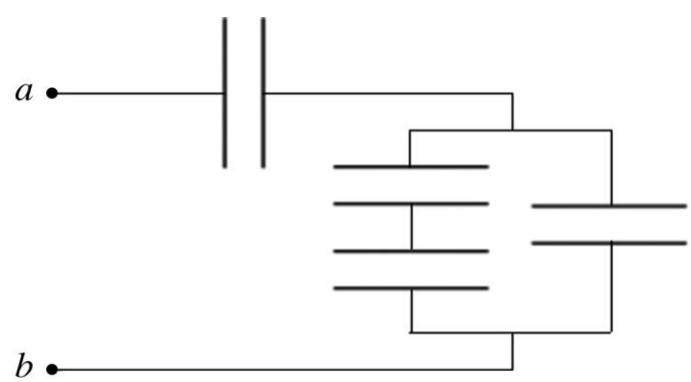


A) 0.40 J. B) 0.60 J C) 0.30 J. D) 0.20 J. E) 0.50 J.

10) A narrow copper wire of length L and radius b is attached to a wide copper wire of length L and radius $2b$, forming one long wire of length $2L$. This long wire is attached to a battery, and a current is flowing through it. If the electric field in the narrow wire is E, the electric field in the wide wire is

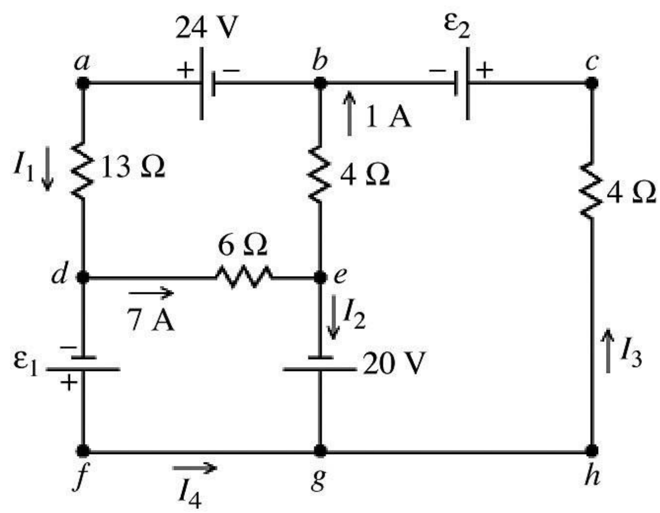
A) E. B) $2E$. C) $E/2$. D) $E/4$. E) $4E$.

11) The capacitors in the network shown in the figure all have a capacitance of 5.0 μF. What is the equivalent capacitance, C_{ab}, of this capacitor network?



A) 10 μF B) 20 μF C) 5.0 μF D) 1.0 μF E) 3.0 μF

12) A multi-loop circuit is shown in the figure. **It is not necessary to solve the entire circuit.** The current I_2 is closest to:

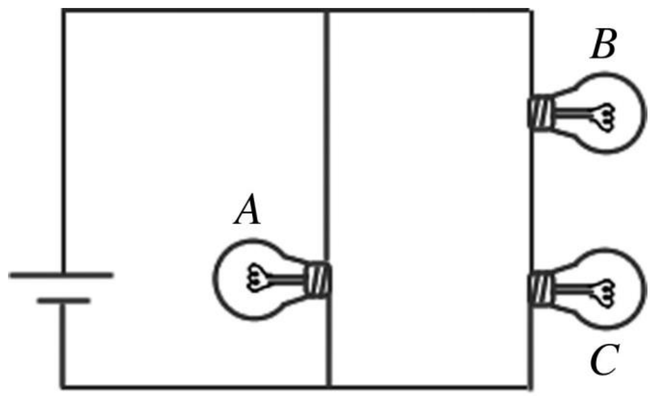


A) zero. B) 6 A. C) -6 A. D) 8 A. E) -8 A.

13) A 4.0-µF capacitor that is initially uncharged is connected in series with a 4.0-kΩ resistor and an ideal 17.0-V battery. How much energy is stored in the capacitor 17 ms after the battery has been connected?

A) 15,000 kJ B) 890 nJ C) 250,000 nJ D) 25 µJ

14) In the circuit shown in the figure, all the lightbulbs are identical. Which of the following is the correct ranking of the brightness of the bulbs?



A) *A* and *B* have equal brightness, and *C* is the dimmest.
B) *B* and *C* have equal brightness, and *A* is the dimmest.
C) *A* is brightest, *C* is dimmest, and *B* is in between.
D) *A* is the brightest, and *B* and *C* have equal brightness but less than *A*.
E) All three bulbs have the same brightness.

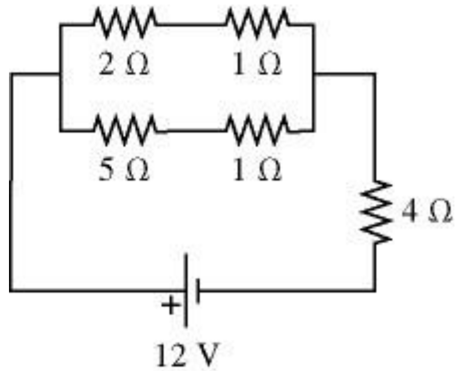
15) The resistivity of gold is $2.44 \times 10^{-8}\ \Omega \cdot \text{m}$ at room temperature. A gold wire that is 1.8 mm in diameter and 11 cm long carries a current of 170 mA. How much power is dissipated in the wire?

A) 0.025 mW B) 0.013 mW C) 0.019 mW D) 0.030 mW E) 0.0076 mW

16) If the current density in a wire of radius R is given by $J = kr$, $0 < r < R$, what is the current in the wire?

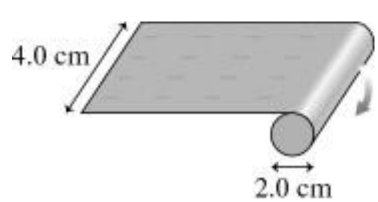
A) kR^2 B) $kR^2/2$ C) $3\pi kR^3/2$ D) $kR^3/3$ E) $2\pi kR^3/3$

17) For the circuit shown in the figure, all quantities are accurate to 3 significant figures. What is the power dissipated in the 2-Ω resistor?



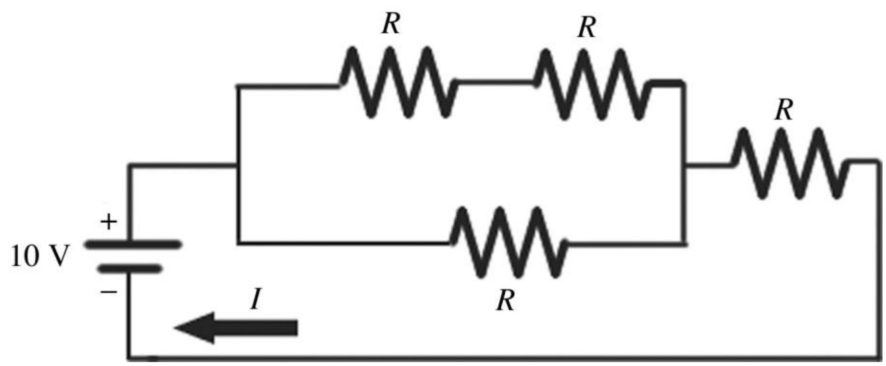
A) 3.56 W B) 2.67 W C) 8.0 W D) 6.67 W E) 5.33 W

18) The figure shows a 2.0-cm diameter roller that turns at 90 rpm. A 4.0-cm wide plastic film is being wrapped onto the roller, and this plastic carries an excess electric charge having a uniform surface charge density of 5.0 nC/cm^2. What is the current of the moving film?



A) 23 μA B) 11 μA C) 30 nA D) 190 nA E) 300 nA

19) When four identical resistors are connected to an ideal battery of voltage $V = 10$ V as shown in the figure, the current I is equal to 0.20 A. What is the value of the resistance R of the resistors?



A) 30 Ω B) 10 Ω C) 20 Ω D) 50 Ω E) 40 Ω

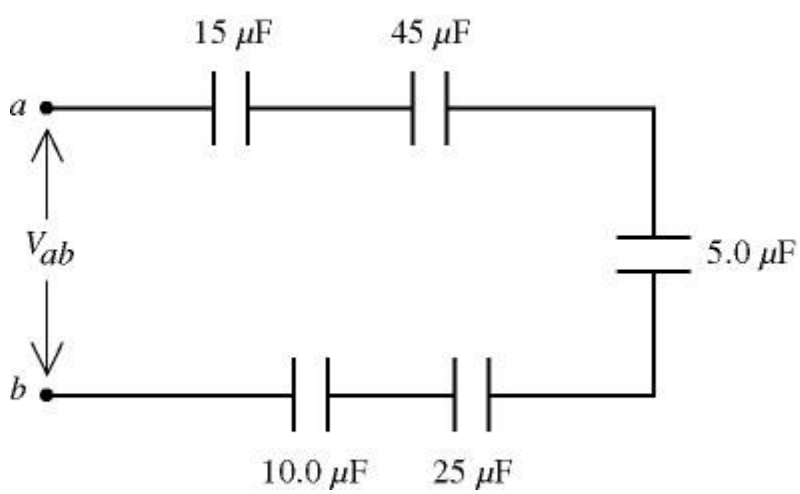
20) An electron has an initial velocity of $\vec{v} = v_1\hat{x} + v_2\hat{z}$ moving in a magnetic field B_0 oriented in the $\hat{x}$-direction. What is the motion of the electron due to the magnetic field?

A) Helical motion starting with $-\hat{y}$ movement
B) Helical motion starting with $+\hat{y}$ movement
C) Circular motion starting with $-\hat{y}$ movement
D) Circular motion starting with $+\hat{y}$ movement
E) Continuous trajectory in the $-\hat{y}$ direction
F) Continuous trajectory in the $+\hat{y}$ direction

21) A thin copper rod that is 1.0 m long and has a mass of 0.050 kg is in a magnetic field of 0.10 T. What minimum current in the rod is needed in order for the magnetic force to cancel the weight of the rod?

A) 4.9 A B) 2.5 A C) 7.6 A D) 1.2 A E) 9.8 A

22) Five capacitors are connected across a potential difference V_{ab} as shown in the figure. Because of the dielectrics used, each capacitor will break down if the potential across it exceeds 30.0 V. The largest that V_{ab} can be without damaging any of the capacitors is closest to:



A) 6.0 V.
B) 30 V.
C) 150 V.
D) 580 V.
E) 64 V.

23) An ideal air-filled parallel-plate capacitor has round plates and carries a fixed amount of equal but opposite charge on its plates. All the geometric parameters of the capacitor (plate diameter and plate separation) are now DOUBLED. If the original capacitance was C_0, what is the new capacitance?

A) $C_0/2$ B) $2C_0$ C) C_0 D) $4C_0$ E) $C_0/4$

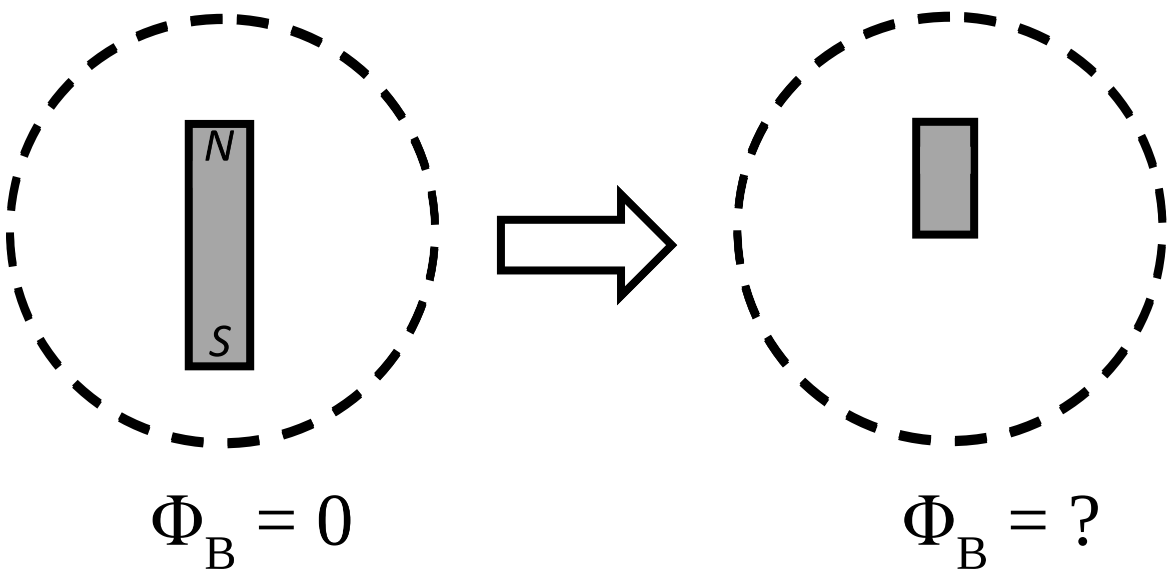
24) A circular loop of diameter 10 cm, carrying a current of 0.20 A, is placed inside a magnetic field $\vec{B} = 0.30\ \text{T}\ \hat{k}$. The normal to the loop is parallel to a unit vector $\hat{n} = -0.60\hat{i} - 0.80\hat{j}$. Calculate the magnitude of the torque on the loop due to the magnetic field.

A) zero B) 0.60×10^{-4} N • m C) 1.2×10^{-4} N • m D) 4.7×10^{-4} N • m E) 2.8×10^{-4} N • m

25) Each plate of a parallel-plate air-filled capacitor has an area of 0.0020 m^2, and the separation of the plates is 0.020 mm. An electric field of $3.9*10^6$ V/m is present between the plates. What is the surface charge density on the plates?

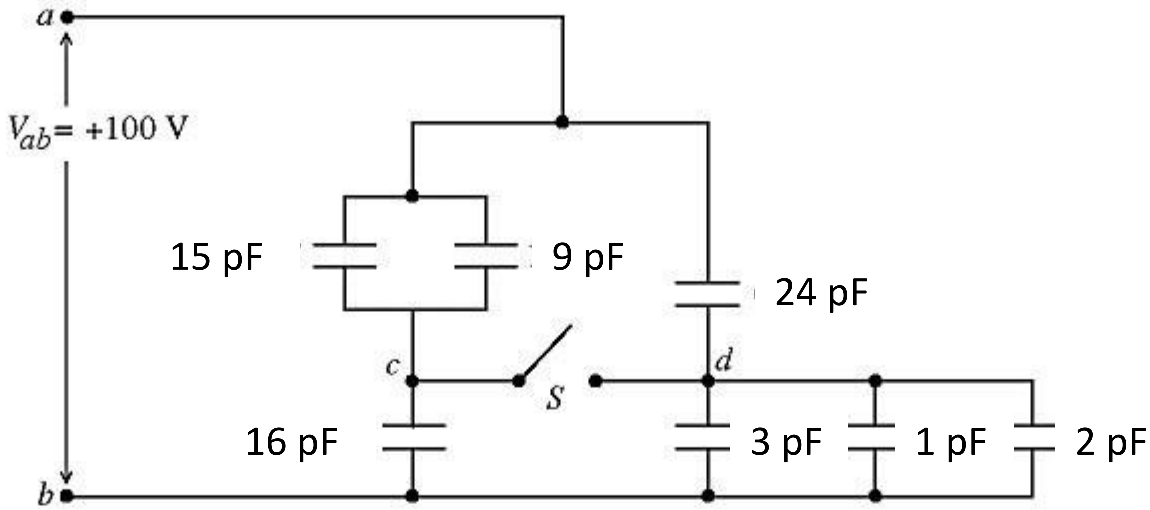
A) 87 $\mu C/m^2$ B) 35 $\mu C/m^2$ C) 73 $\mu C/m^2$ D) 52 $\mu C/m^2$ E) 17 $\mu C/m^2$

26) We initially have the bar magnet on the left side of the figure. We draw a spherical Gaussian surface around that bar magnet and find that the flux, Φ_B, is zero through that Gaussian surface. All of a sudden, the bottom half of the magnet breaks apart. What happens to the flux through that same surface?



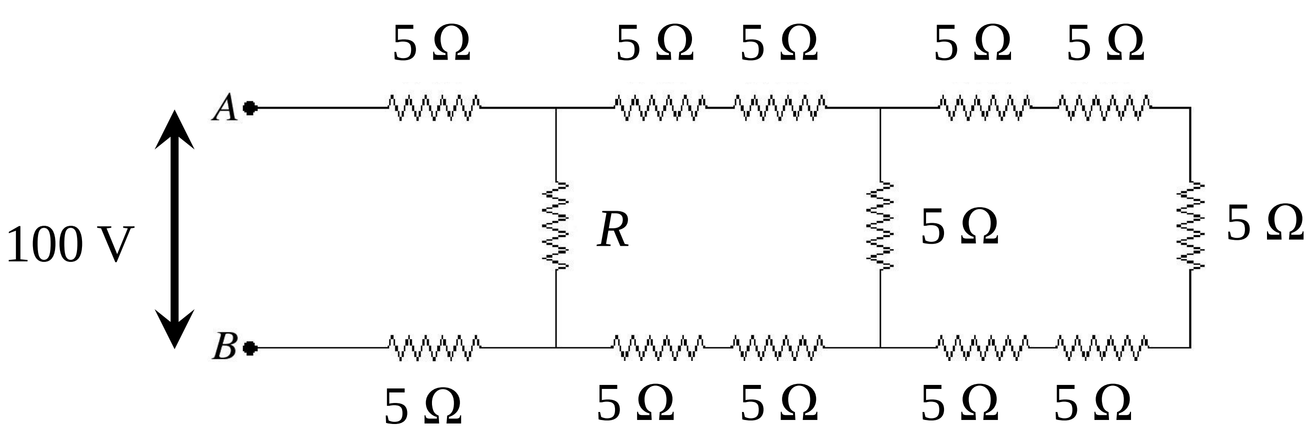
A) Increases B) Decreases C) Stays the same

27) Initially uncharged capacitors form the capacitive network shown below. A potential difference, V_{ab} = +100 V, is applied across the network with the switch, *S*, left open. What is the potential difference V_{cd} across the open switch, *S*?



A) 20 V B) -20 V C) 40 V D) -40 V E) 60 V

28) A resistor network, as seen below, is assembled. A 100 V potential difference is applied between terminals A and B. What value of *R* is required for 8.44 A to flow between A and B?



A) 10 Ω B) 5 Ω C) 3 Ω D) 2 Ω E) 1 Ω

29) We have a ¼ W resistor hooked up to a battery at temperature, T_0. We apply 10 V across this resistor at this temperature, such that the amount of power dissipation is exactly ¼ W. Next, we dunk this resistor into liquid nitrogen, which drops to the temperature to $T_1 = T_0/2$. If resistance scales as T^2, how much voltage can we apply when *R* is at T_1 without damaging the resistor (i.e., exceeding ¼ W)?

A) 1 V B) 2.5 V C) 5 V D) 20 V E) 40 V

$$e = 1.60 * 10^{-19}\ \mathrm{C}$$
$$m_e = 9.11 * 10^{-31}\ \mathrm{kg}$$
$$\epsilon_0 = 8.85 * 10^{-12}\ \mathrm{C}^2/\mathrm{N}\text{-}\mathrm{m}^2$$
$$\oiint \vec{E} \cdot d\vec{A} = \frac{1}{\epsilon} Q_{\mathrm{free}}^{\mathrm{enclosed}}, \text{ where } \epsilon = K\epsilon_0$$
$$Q = CV$$
$$U = \frac{Q^2}{2C} = \frac{1}{2}CV^2 = \frac{1}{2}QV$$
$$\vec{J} = nq\vec{v}_d$$
$$V = IR$$
$$\vec{E} = \rho\vec{J}$$
$$R = \frac{\rho L}{A}$$
$$P = I^2R$$
$$\vec{F} = q\left(\vec{E} + \vec{v} \times \vec{B}\right)$$
$$\Phi_{\mathrm{B}} = \iint \vec{B} \cdot d\vec{A}$$
$$\oiint \vec{B} \cdot d\vec{A} = 0$$
$$\vec{F} = I\left(\vec{\ell} \times \vec{B}\right)$$
$$\vec{\mu} = I\vec{A}$$
$$\vec{\tau} = \vec{\mu} \times \vec{B}$$
$$U = -\vec{\mu} \cdot \vec{B}$$