Exam

Name_____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) 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 energy density between the plates was u_0, what is the new energy density? 1) _____

A) $16u_0$ B) $4u_0$ C) $u_0/16$ D) u_0 E) $u_0/4$

2) 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 energy stored in the capacitor was U_0, how much energy does it now store? 2) _____

A) $U_0/4$ B) U_0 C) $2U_0$ D) $U_0/2$ E) $4U_0$

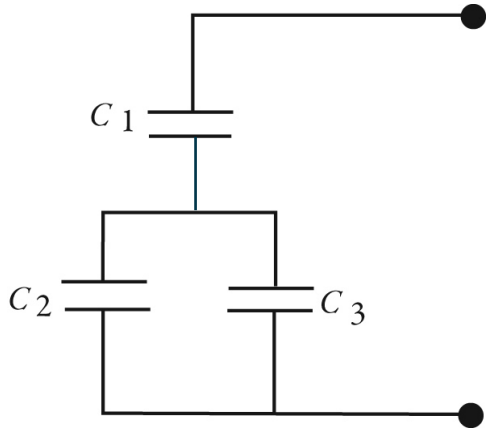
3) Two capacitors, C_1 and C_2, are connected in series across a source of potential difference. With the potential source still connected, a dielectric is now inserted between the plates of capacitor C_1. What happens to the charge on capacitor C_2? 3) _____

A) The charge on C_2 remains the same.

B) The charge on C_2 decreases.

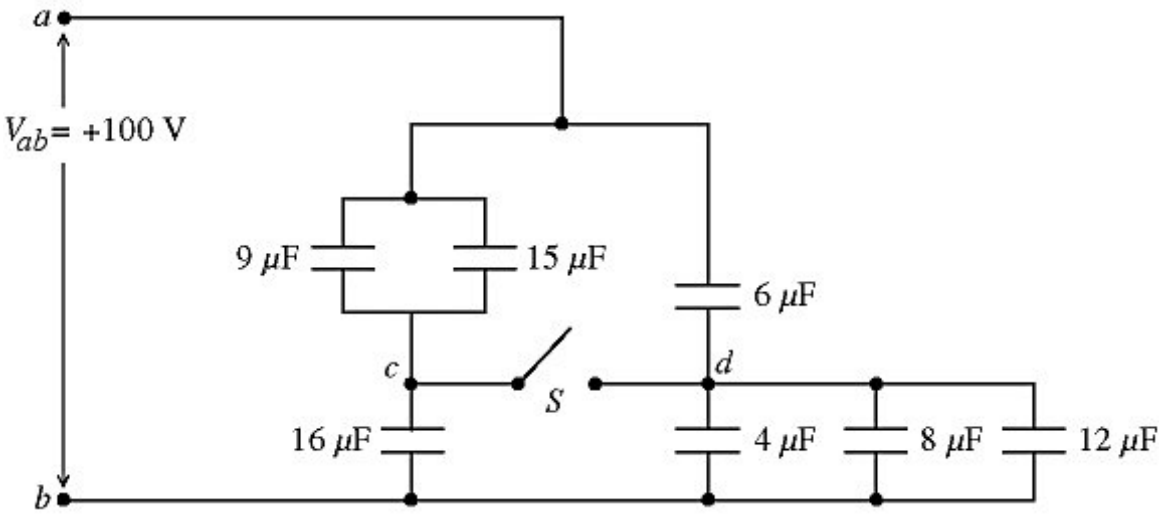
C) The charge on C_2 increases.

4) Three capacitors are arranged as shown in the figure. C_1 has a capacitance of 5.0 pF, C_2 has a capacitance of 10.0 pF, and C_3 has a capacitance of 15.0 pF. Find the voltage drop across the entire arrangement if the voltage drop across C_2 is 311 V. 4) _____



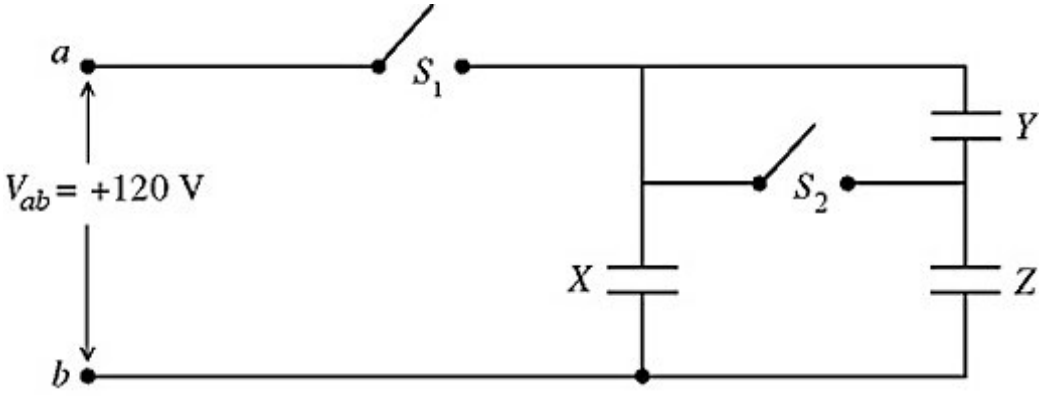
A) 570 V B) 1200 V C) 520 V D) 1900 V

5) The capacitive network shown in the figure is assembled with initially uncharged capacitors. A potential difference, V_{ab} = +100V, is applied across the network. The switch *S* in the network is kept open. Assume that all the capacitances shown are accurate to two significant figures. What is potential difference V_{cd} across the open switch *S*? 5) _____



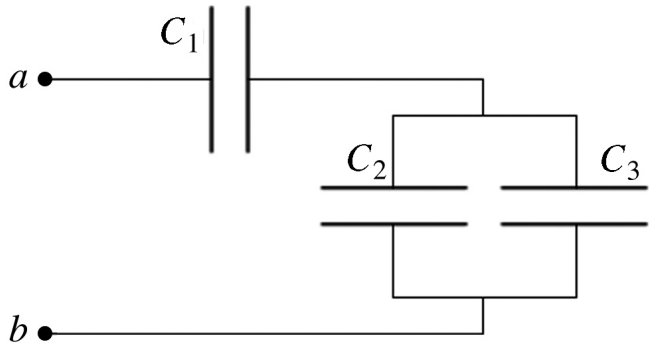
A) 40 V B) 60 V C) 70 V D) 50 V E) 0 V

6) The network shown in the figure is assembled with uncharged capacitors *X*, *Y*, and *Z*, with C_X = 7.0 μF, C_Y = 7.0 μF, and C_Z = 6.0 μF, and open switches, S_1 and S_2. A potential difference V_{ab} = +120 V is applied between points *a* and *b*. After the network is assembled, switch S_1 is closed for a long time, but switch S_2 is kept open. Then switch S_1 is opened and switch S_2 is closed. What is the final voltage across capacitor *X*? 6) _____



A) 87 V B) 71 V C) 63 V D) 94 V E) 79 V

7) Three capacitors, with capacitances C_1 = 4.0 μF, C_2 = 3.0 μF, and C_3 = 2.0 μF, are connected to a 12 -V voltage source, as shown in the figure. What is the charge on capacitor C_2? 7) _____

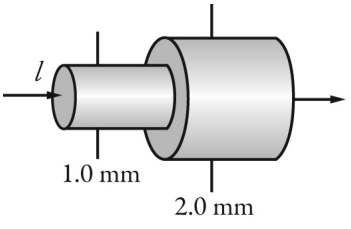


A) 16 μC B) 4.0 μC C) 8.0 μC D) 2.0 μC E) 32 μC

8) An ideal parallel-plate capacitor consists of a set of two parallel plates of area A separated by a very small distance d. When the capacitor plates carry charges $+Q$ and $-Q$, the capacitor stores energy U_0. If the separation between the plates is doubled, how much electrical energy is stored in the capacitor? 8) _____

A) $U_0/4$ B) U_0 C) $U_0/2$ D) $2U_0$ E) $4U_0$

9) The figure shows two connected wires that are made of the same material. The current entering the wire on the left is 2.0 A and in that wire the electron drift speed is v_d. What is the electron drift speed in the wire on the right side? 9) _____



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

10) When a voltage difference is applied to a piece of metal wire, a 5.0-mA current flows through it. If this metal wire is now replaced with a silver wire having twice the diameter of the original wire, how much current will flow through the silver wire? The lengths of both wires are the same, and the voltage difference remains unchanged. (The resistivity of the original metal is 1.68×10^{-8} Ω • m, and the resistivity of silver is 1.59×10^{-8} Ω • m.) 10) _____

A) 21 mA B) 19 mA C) 5.3 mA D) 11 mA

11) The voltage and power ratings of a particular light bulb, which are its normal operating values, are 110 V and 60 W. Assume the resistance of the filament of the bulb is constant and is independent of operating conditions. If the light bulb is operated at a reduced voltage and the power drawn by the bulb is 36 W, what is the operating voltage of the bulb? 11) _____

A) 66 V B) 85 V C) 90 V D) 72 V E) 78 V

12) A proton beam that carries a total current of 1.3 mA has 10.0 mm diameter. The current density in the proton beam increases linearly with distance from the center. This is expressed mathematically as $J(r) = J_0 (r/R)$, where R is the radius of the beam and J_0 is the current density at the edge. Determine the value of J_0. 12) _____

A) 6.2 A/m^2 B) 17 A/m^2 C) 25 A/m^2 D) 12 A/m^2

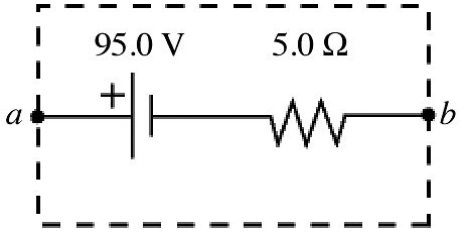
13) The voltage and power ratings of a particular light bulb, which are its normal operating values, are 110 V and 60 W. Assume the resistance of the filament of the bulb is constant and is independent of operating conditions. If the light bulb is operated with a current that is 50% of the current rating of the bulb, what is the actual power drawn by the bulb? 13) _____

A) 20 W B) 10 W C) 30 W D) 25 W E) 15 W

14) An electric device delivers a current of 5.0 A to a device. How many electrons flow through this device in 10 s? ($e = 1.60 \times 10^{-19}$ C) 14) _____

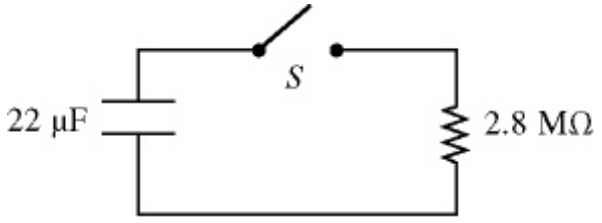
A) 2.0
B) 20
C) 31×10^{20}
D) 0.20
E) 3.1×10^{20}

15) The emf and the internal resistance of a battery are as shown in the figure. If a current of 8.3 A is drawn from the battery when a resistor R is connected across the terminals ab of the battery, what is the power dissipated by the resistor R? 15) _____



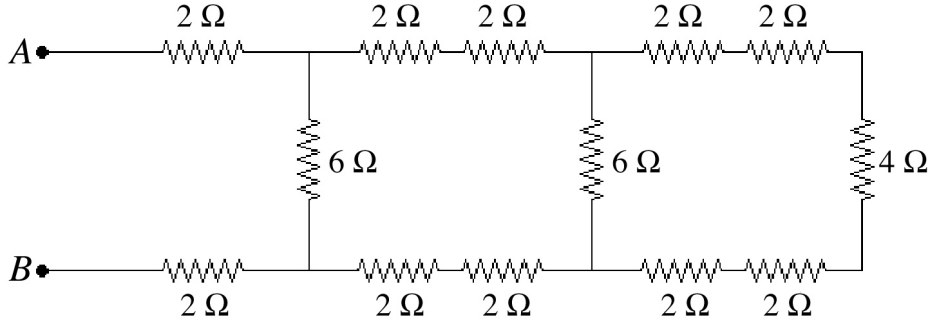
A) 700 W B) 790 W C) 440 W D) 620 W E) 530 W

16) For the circuit shown in the figure, the switch *S* is initially open and the capacitor voltage is 80 V. The switch is then closed at time $t = 0$. How long after closing the switch will the current in the resistor be 7.0 μA? 16) _____



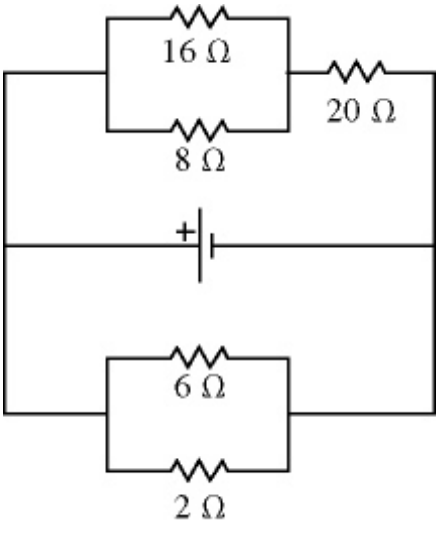
A) 78 s B) 87 s C) 61 s D) 95 s E) 69 s

17) Thirteen resistors are connected across points *A* and *B* as shown in the figure. If all the resistors are accurate to 2 significant figures, what is the equivalent resistance between points *A* and *B*? 17) _____



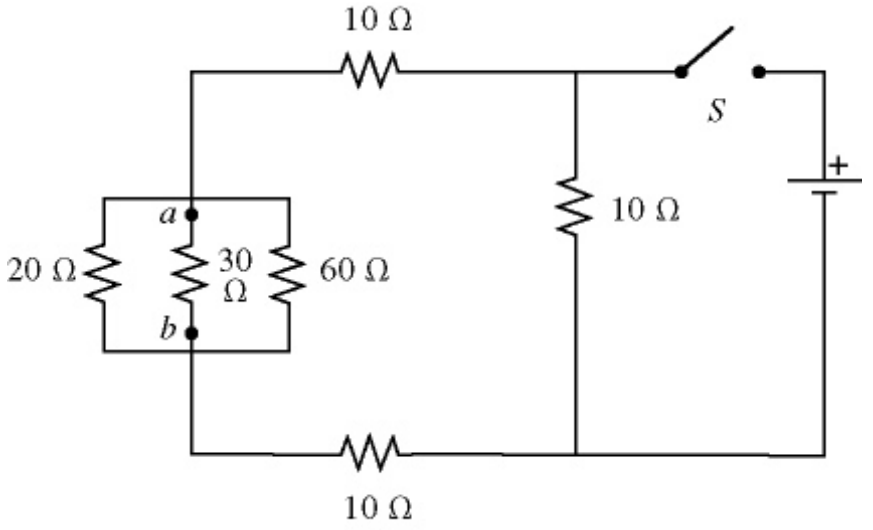
A) 10 Ω B) 8.0 Ω C) 12 Ω D) 6.0 Ω E) 4.0 Ω

18) For the circuit shown in the figure, the current in the 8-Ω resistor is 0.50 A, and all quantities are accurate to 2 significant figures. What is the current in the 2-Ω resistor? 18) _____



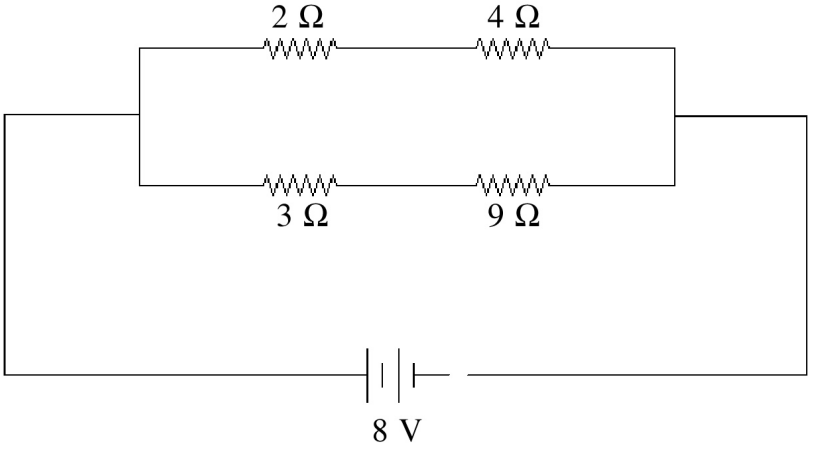
A) 4.5 A B) 2.25 A C) 6.4 A D) 9.5 A E) 0.75 A

19) In the circuit shown in the figure, an ideal ohmmeter is connected across *ab* with the switch *S* open. All the connecting leads have negligible resistance. The reading of the ohmmeter will be closest to 19) _____



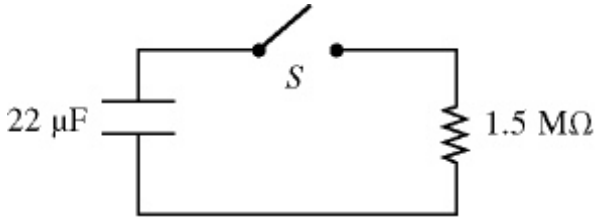
A) 7.5 Ω. B) 60 Ω. C) 10 Ω. D) 40 Ω. E) 30 Ω.

20) Four resistors are connected across an 8-V DC battery as shown in the figure. The current through the 9-Ω resistor is closest to 20) _____



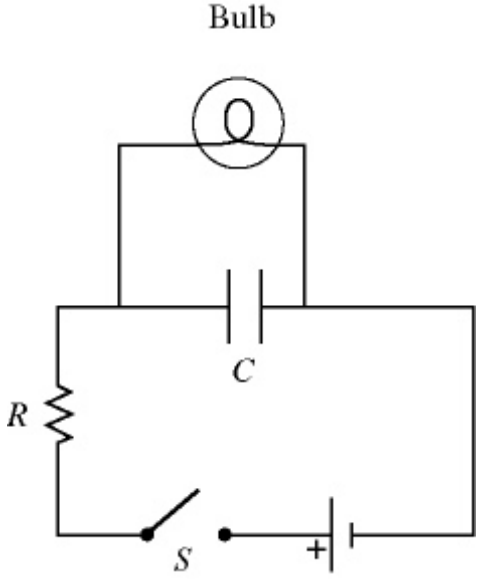
A) 0.7 A. B) 1 A. C) 0.9 A. D) 0.5 A. E) 2 A.

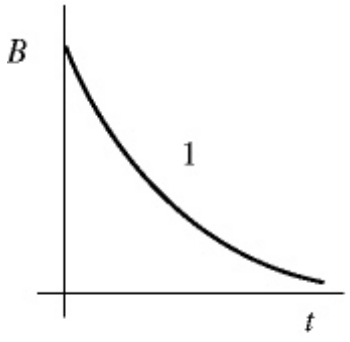
21) For the circuit shown in the figure, the switch *S* is initially open and the capacitor voltage is 80 V. The switch is then closed at time $t = 0$. What is the charge on the capacitor when the current in the circuit is 33 μA? 21) _____

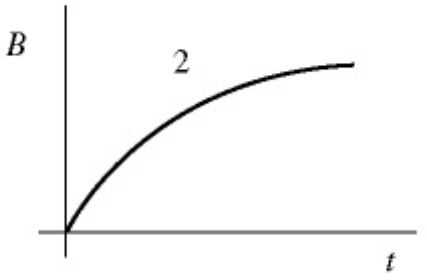


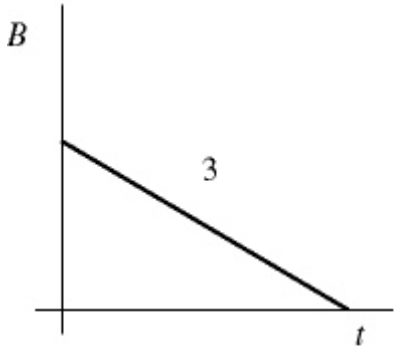
A) 1000 μC B) 890 μC C) 1100 μC D) 960 μC E) 830 μC

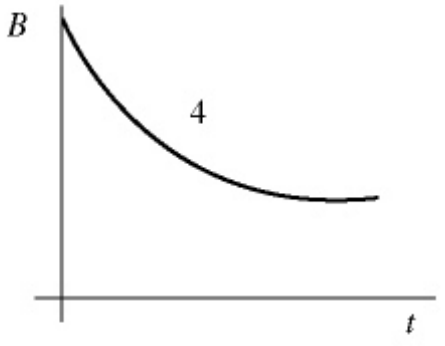
22) A light bulb is connected in the circuit shown in the figure with the switch *S* open and the capacitor uncharged. The battery has no appreciable internal resistance. Which one of the following graphs best describes the brightness *B* of the bulb as a function of time *t* after closing the switch? 22) _____

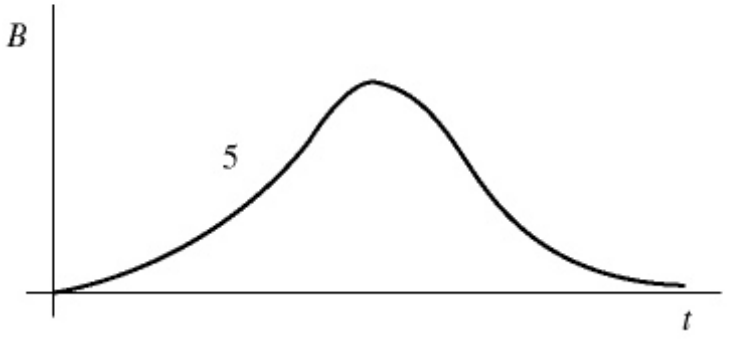












A) 1 B) 2 C) 3 D) 4 E) 5

23) 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. 23) _____

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

24) A beam of electrons is accelerated through a potential difference of 10 kV before entering a region having uniform electric and magnetic fields that are perpendicular to each other and perpendicular to the direction in which the electron is moving. If the magnetic field in this region has a value of 0.010 T, what magnitude of the electric field is required if the particles are to be undeflected as they pass through the region? 24) _____

A) 2.3×10^3 V/m

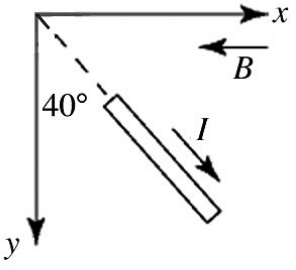
B) 7.9×10^3 V/m

C) 7.2×10^6 V/m

D) 5.9×10^5 V/m

E) 6.0×10^5 V/m

25) A wire segment 1.2 m long carries a current $I = 3.5$ A and is oriented as shown in the figure. A uniform magnetic field of magnitude 0.50 T pointing toward the $-x$ direction is present as shown. The $+z$-axis points directly into the page. What is the magnetic force vector on the wire segment? 25) _____



A) -1.6 N $\hat{k}$

B) (-1.3 $\hat{j}$ + 1.6 $\hat{k}$ N

C) +1.6 N $\hat{j}$

D) (+1.3 $\hat{j}$ - 1.6 $\hat{k}$) N

E) +1.6 N $\hat{k}$

26) A particle with charge -5.00 C initially moves at $\vec{v}$ = (1.00 $\hat{i}$ + 7.00 $\hat{j}$) m/s. If it encounters a magnetic field $\vec{B}$ = 10.00 T $\hat{k}$, find the magnetic force vector on the particle. 26) _____

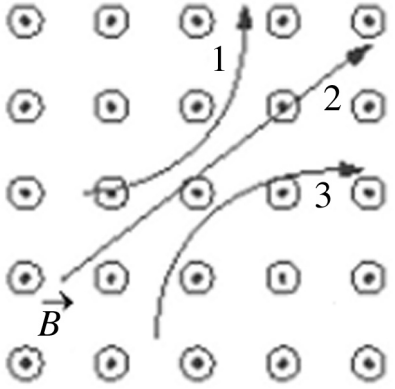
A) (-350 $\hat{i}$ - 50.0 $\hat{j}$) N

B) (350 $\hat{i}$ - 50.0 $\hat{j}$) N

C) (-350 $\hat{i}$ + 50.0 $\hat{j}$) N

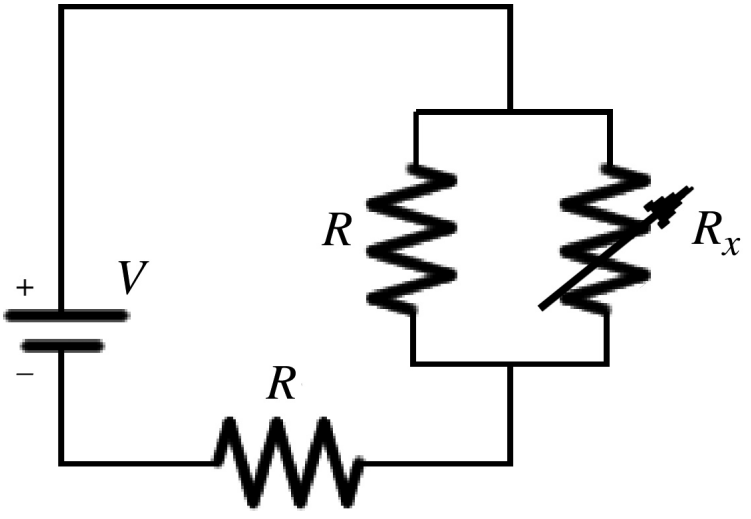
D) (350 $\hat{i}$ + 50.0 $\hat{j}$) N

27) Three particles travel through a region of space where the magnetic field is out of the page, as shown in the figure. The electric charge of each of the three particles is, respectively, 27) _____



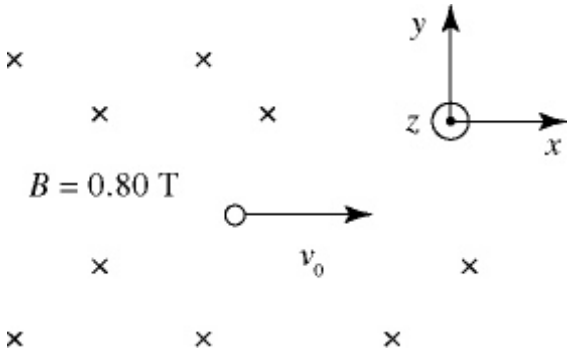
A) 1 is positive, 2 is negative, and 3 is neutral.
B) 1 is positive, 2 is neutral, and 3 is negative.
C) 1 is neutral, 2 is negative, and 3 is positive.
D) 1 is negative, 2 is neutral, and 3 is positive.
E) 1 is neutral, 2 is positive, and 3 is negative.

28) Two identical resistors of resistance R = 24 Ω and a variable resistor R_x are connected to an ideal battery of voltage V as shown in the figure. What should be the value of the variable resistance R_x to make the voltage across the two parallel resistors equal to $\frac{V}{5}$? 28) _____



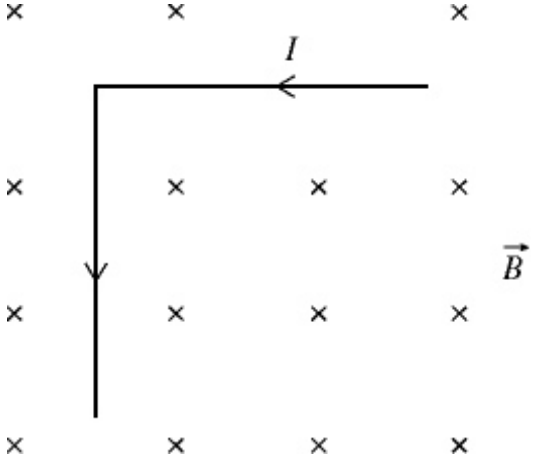
A) 24 Ω B) 4.0 Ω C) 8.0 Ω D) 40 Ω E) 16 Ω

29) A uniform magnetic field of magnitude 0.80 T in the negative z-direction is present in a region of space, as shown in the figure. A uniform electric field is also present. An electron that is projected with an initial velocity $v_0 = 9.1 \times 10^4$ m/s in the positive x-direction passes through the region without deflection. What is the electric field vector in the region? 29) _____



A) +110 kV/m $\hat{i}$
B) -73 kV/m $\hat{j}$
C) +73 kV/m $\hat{i}$
D) -110 kV/m $\hat{j}$
E) +110 kV/m $\hat{j}$

30) An L-shaped metal machine part is made of two equal-length segments that are perpendicular to each other and carry a 4.50-A current as shown in the figure. This part has a total mass of 3.80 kg and a total length of 3.00 m, and it is in an external 1.20-T magnetic field that is oriented perpendicular to the plane of the part, as shown. What is the magnitude of the NET magnetic force that the field exerts on the part? 30) _____

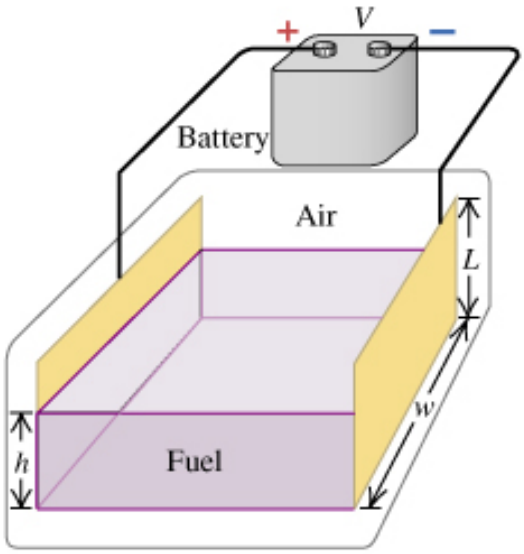


A) 16.2 N B) 32.4 N C) 8.10 N D) 22.9 N E) 11.5 N

31. A charged capacitor stores energy U. Without connecting this capacitor to anything, dielectric having dielectric constant K is now inserted between the plates of the capacitor, completely filling the space between them. How much energy does the capacitor now store?

A) KU B) U/K C) U/2K D) 2KU E) U

32. A fuel gauge uses a capacitor to determine the height of the fuel in a tank. The effective dielectric constant K_{eff} changes from a value of 1 when the tank is empty to a value of K, the dielectric constant of the fuel, when the tank is full. The appropriate electronic circuitry can determine the effective dielectric constant of the combined air and fuel between the capacitor plates. Each of the two rectangular plates has a width w and a length L (The Figure). The height of the fuel between the plates is h. You can ignore any fringing effects.



Derive an expression for K_{eff} as a function of h.

Express your answer in terms of the variables K, h, and L.

A) K(1 – h/L)
B) 1+ Kh/L
C) 1 + Kh/L – h/L
D) (1 + K)h/L
E) (K-1)h/L

33. Two square air-filled parallel plates that are initially uncharged are separated by 1.2 mm, and each of them has an area of 190 mm^2. How much charge must be transferred from one plate to the other if 1.1 nJ of energy are to be stored in the plates?

A) 78 pC B) 39 pC C) 56 pC D) 3.5 μC E) 10 μC

34. A parallel-plate capacitor has a capacitance of 10 mF and charged with a 20-V power supply. The power supply is then removed and a dielectric material of dielectric constant 4.0 is used to fill the space between the plates. How much energy is now stored by the capacitor?

A) 62.5 mJ B) 125 mJ C) 250 mJ D) 1200 mJ E) 500 mJ

35. In the 100 T magnet at Los Alamos, the insert is electrified by a large (4 MJ) capacitor bank. Let's model the capacitor bank and magnet as a simple capacitor in series with a resistor. If the resistance of the 100 T magnet is 1 Ω, how much charge goes through the magnet in 3 ms?

A) 2000 A B) 2000 C C) $6.7*10^5$ C D) 6 C E) $1.2*10^4$ C

Answer Key
Testname: PRACTICE EXAM 2

1) C
2) D
3) C
4) D
5) A
6) D
7) A
8) D
9) B
10) A
11) B
12) C
13) E
14) E
15) C
16) B
17) B
18) D
19) A
20) A
21) C
22) B
23) E
24) D
25) E
26) C
27) D
28) C
29) B
30) E
31) B
32) C
33) C
34) E
35) D