Exam 3 Name KEY

22 Questions

*SEE NOTES

Select the one response that **best** answers each question.

Several ways to get this: $W = F \cdot d$ * $= -\Delta PE$

1) A region of space contains a uniform electric field given by $E = 45\,\hat{i} + 45\,\hat{j}$. The units are SI. A charge of 12.0 C is released from rest at the origin. What is the magnitude of the electric force acting on the charge?

A) 540 N $|\vec{F}| = |q\vec{E}| = 12\sqrt{45^2+45^2} = 764\text{N}$ B) 1080 N C) 48600 N D) 764 N ✓

☺ in direction of $\vec{E}$, since q is "+"

2) If the charge in question (1) is moved 1.50 meters by the electric force, by how much has its electric potential energy changed? Report the magnitude of the change in electric potential energy.

OR $\Delta V = Ed$

A) 1620 J B) 810 J C) 67.5 J D) 1146 J ✓

and $PE = q\Delta V = qEd = 12 * 63.64 * 1.5 = 1146\text{J}$

3) For the charge in question (1), what is the difference in voltage between its starting point (at the origin) and the point 1.5 meters away, where it has been moved by the electic force in question (2) ?

Again, several ways. $\Delta V = Ed = 95.5$

A) There is no way to tell becasue we do not know what is producing the electric field.
B) 95.5 V, with it moving to a lower voltage. ✓ $F = qE$ VOLTAGE → P.E. SEE CLASS NOTES
C) 95.5 V with it moving to a higher voltage. $\vec{E}$ from high voltage to low voltage.
D) There is no difference since the charge is not passing through a circuit element.

4) If the charge in question (1) and (2) had been negative, what is the difference in voltage between its starting point (at the origin) and the point 1.5 meters away, where it has been moved by the electic force in question (2) ?

A) 95.5 V with it moving to a higher voltage. $\vec{F} = q\vec{E}$. Would move 1.5 meters in opposite direction of $\vec{E}$
B) There is no way to tell becasue we do not know what is producing the electric field.
C) There is no difference since the charge is not passing through a circuit element.
D) 95.5 V, with it moving to a lower voltage. All else same ☺

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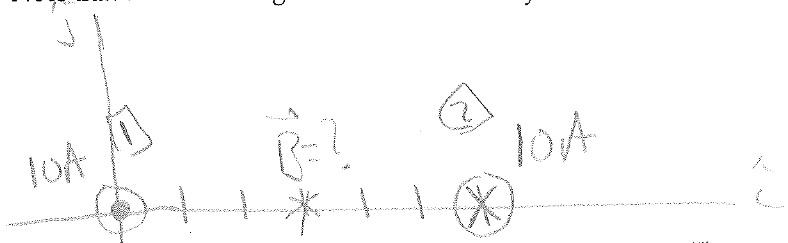
5) Two wires are sepearated by a distance of 6.0 meters. One is located at x=0 and extends along the z-axis, carrying a curent of 10.0 A out of the page. The other is located at x= 6.0, also extending along the z-axis, and carries a current of 10.0 A into the page. What is the magnitude and direction of the magnetic field at a point exactly half way between the two wires? Note that a standard right hand coordinate system that has +x to the right and +y up would have +z out.

A) 6.7×10^{-6} T up
B) 0 T
C) 1.3×10^{-6} T up ✓
D) 1.3×10^{-6} T down
E) 6.7×10^{-6} T down

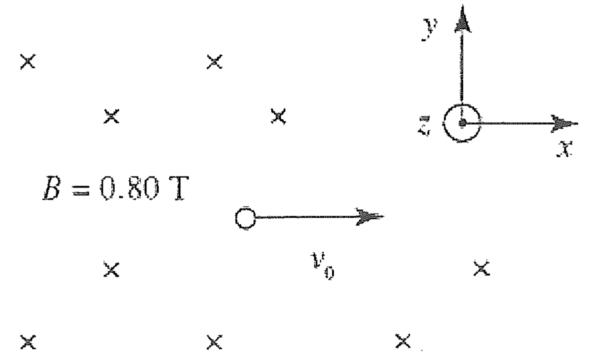


$\vec{B}_{1} = \frac{\mu_0(10)}{2\pi(3)} = 6.67\times10^{-7}$ $\boxed{\text{up}}$ $(+\hat{j})$

$\vec{B}_{2} = \frac{\mu_0(10)}{2\pi(3)} = 6.67\times10^{-7}$ $\boxed{\text{up}}$ $(+\hat{j})$

$\vec{B}_{TOTAL} = 1.3\times10^{-6}$ $\boxed{\text{up}}$ $(+\hat{j})$

6) 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 below. A uniform electric field of 76,000 V/m in the $+y$ direction is also present. Note that this electric field is not shown in the diagram. An electron is projected with an initial velocity $v_0 = 9.5 \times 10^4$ m/s in the $+x$ direction. At that instant, what is the y component of the force on the electron ?



$\vec{E} = 76000\,\hat{j}$

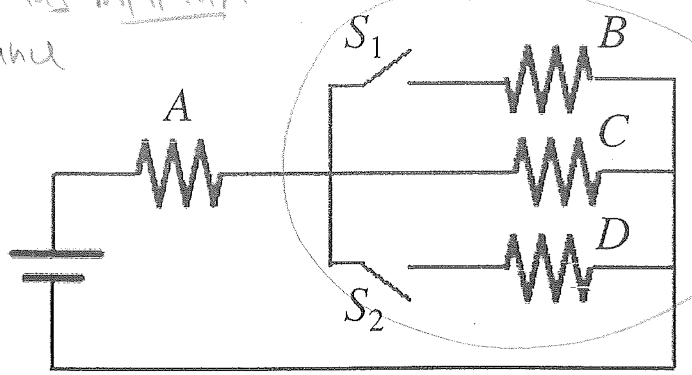
A) $+2.4 \times 10^{-14}$ N
B) $+1.0 \times 10^{-14}$ N
C) zero
D) -2.4×10^{-14} N ✓
E) -1.0×10^{-14} N

$\vec{F} = q\vec{E} + q\vec{v}\times\vec{B} = q[\vec{E} + \vec{v}\times\vec{B}]$

$\vec{F} = -1.6\times10^{-19}[76000\,\hat{j} + (9.5\times10^{4})(0.8)\sin(90)\,\hat{j}]$

$\vec{F} = -2.4\times10^{-14}\,\hat{j}$

7) In the circuit shown in the figure, four identical resistors labeled A to D are connected to a battery as shown. S_1 and S_2 are switches. Which of the following actions would result in the GREATEST amount of current through resistor A? ∴ Circuit has minimum resistance

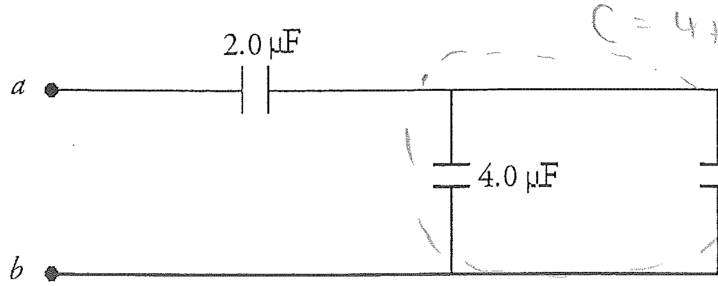


All in ∥ has less resistance than any single one of them.

A) closing S_1 only
B) leaving both switches open as shown.
C) closing both switches ✓
D) closing S_2 only

8) Three capacitors are connected as shown in the figure. What is the equivalent capacitance between points a and b?

$C = 4 + 6 = 10\,\mu F$



2 μF
10 μF

$\frac{1}{C} = \frac{1}{2} + \frac{1}{10}$

$\therefore C = \frac{10}{6}\,\mu F$

1.7 μF

A) 8.0 μF
B) 4.0 μF
C) 1.7 μF ✓
D) 7.1 μF
E) 12 μF

+30 1.67μF Q=CU=50μC ‖ "C in series have same charge" SEE NOTES

9) In question (8), a 30 V battery is conected across the points a and b. We wait until there is no current flowing in the circuit. At that time, what is the charge on the 2.0 μF capacitor?

A) 50 μC ✓ B) 0 μC C) 8.5 μC D) 25 μC

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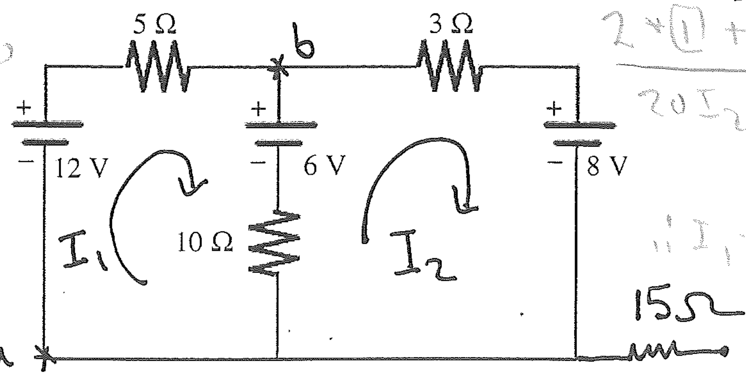
10) For the circuit shown in the figure, all quantities are accurate to 2 significant figures. Consider the two mesh currents shown. Which of the following is a correct equation for the mesh current labelled I_1?

loop 1 $+12-5I_1-6-10I_1+10I_2=0$

(1) $\boxed{-15I_1+10I_2=-6}$

loop 2 $+6-3I_2-8-10I_2+10I_1=0$

(2) $\boxed{+10I_1-13I_2=2}$



$2\times(1)+3\times(2)$:

$20I_2-39I_2=-12+6$

$I_2=0.316$ A

$\therefore I_1=\frac{13I_2+2}{10}=0.611$ A

A) $-15\ I_1+10\ I_2=-6$ ✓ B) $-15\ I_1=-6$ C) $-15\ I_1-10\ I_2=-6$ D) $-15\ I_1-16\ I_2=-6$

11) What is the current in the 10.0 Ω resistor?

.611A .316A

A) 0.32 A B) 0.93 A C) 0.61 A D) 0.30 A ✓

12) What is the voltage between the points labelled 'a' and 'b'?

A) 8.9 V with 'a' at the higher voltage
B) 8.9 V with 'b' at the higher voltage ✓
C) 10.4 V with 'b' at the higher voltage
D) 10.4 V with 'a' at the higher voltage

$\Delta V_{a\to b}=+12-0.611(5)=+8.9$ V

13) What is the voltage across the 15.0 Ω resistor?

A) 0 V No current! B) 14 V C) 4.8 V D) 9.2 V

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14) As more resistors are added in parallel across a constant voltage source, the power supplied by the source ____.

A) decreases. B) does not change. C) increases.

15) An electron moving in the direction of the $+x$-axis enters a magnetic field. If the electron experiences a magnetic force in the $-y$ direction, then the magnetic field in this region points in the direction of the ____. Note that a standard right hand coordinate system that has +x to the right and +y up would have +z out.

IN

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

16) A region of space has a magnetic field given by $B(x,y,z)=(5.6\times10^{-6})\,\hat{i}-(12.0\times10^{-6})\,\hat{j}+(6.0\times10^{-6})\,\hat{k}$. In this region of space there is also a wire located at x=4.0 meters and running along the $\hat{j}$ axis. It carries a current of 100.0 A in the $+\hat{j}$ direction. All units are SI. What is the magnitude of the magnetic field at the point x= 6, y = 12, z= 0 ? All units are SI.

100A

$B_{wire}=\frac{\mu_0(100)}{2\pi(2)}(-\hat{k})=-1\times10^{-5}\hat{k}$

$|\vec{B}_{@\,6,12,0}|=\sqrt{\dots}$

A) 1.38×10^{-5} T ✓ B) 1.66×10^{-5} T C) 1.45×10^{-5} T D) 1.04×10^{-5} T

$\vec{B}_{@(6,12,0)}=\vec{B}(x,y,z)+\vec{B}_{wire}=(5.6\times10^{-6})\hat{i}-(12\times10^{-6})\hat{j}+(6\times10^{-6}-1\times10^{-5})\hat{k}$

$=5.6\times10^{-6}\hat{i}-12\times10^{-6}\hat{j}-4\times10^{-6}\hat{k}$

An 'A' question ☺

$-\frac{\partial V}{\partial x}$ $-\frac{\partial V}{\partial y}$ $-\frac{\partial V}{\partial z}$ Integrate The three Parts and see if we can make results agree

17) A certain region of space contains an electric field given by $E(x,y,z) = -20xy\,\hat{i} - 10x^2\,\hat{j} + 4\,\hat{k}$. Which of the following could be the corresponding electric potential?

A) both (B) and (C) ✓ B) $10x^2y - 4z$ ok C) $10x^2y - 4z + 4$ ← Constant ok D) $-20y - 20x$

$\int 20xy\,dx = 10x^2y + const$

$\int 10x^2\,dy = 10x^2y + const$

$-\int 4\,dz = -4z + const.$

$\therefore V(x,y,z) = 10x^2y - 4z + const$

18) The voltage in a particular region of space is given by the function $V(x,y,z,t) = 7x^2y - 12z^3y + 4zt$. The units are SI. At time t = 23 seconds, what is the voltage at the origin?

$V(0,0,0,23) = 0 - 0 + 0 = 0$

A) 92 V
B) 0 V ✓
C) 23 V
D) There is no way to tell since a zero volt reference point has not been provided.

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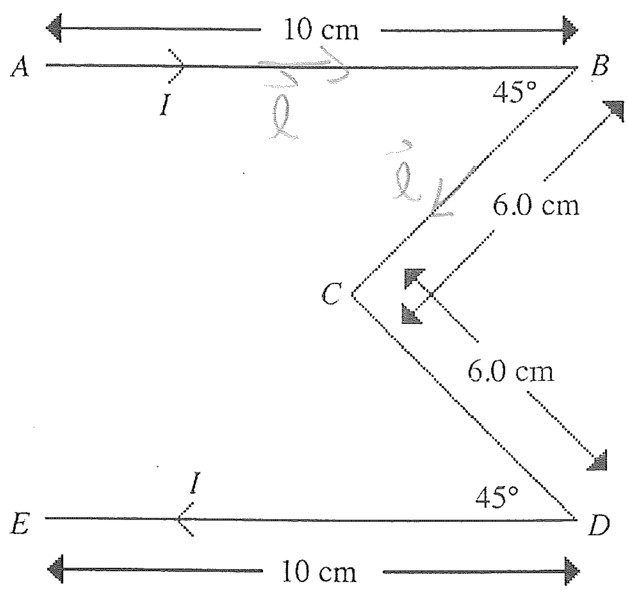
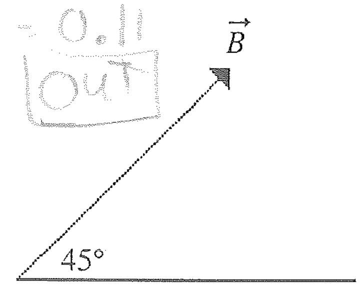
19) A wire in the shape of an "M" lies in the plane of the paper. It carries a current of 2.00 A, flowing from points *A* to *E*, as shown in the figure. It is placed in a uniform magnetic field of 0.75 T in the same plane, directed as shown on the right side of the figure. The figure indicates the dimensions of the wire. What are the magnitude and direction of the force acting on section *AB* of this wire?



$\vec{F}_{AB} = I\vec{l} \times \vec{B} = I|\vec{l}||\vec{B}|\sin(45)$
$= 2(0.1)(0.75)\sin(45)$
$= 0.11$
$\boxed{OUT}$



A) 0.11 N in B) 0.15 N in C) 0.11 N out ✓ D) 0.15 N out

20) For the wire shown in question (19), what is the magnitude and direction of the force acting on section BC?

A) the force is undetermined. B) 0.1 N out
C) 0 N D) 0.1 N in

$\vec{F}_{BC} = I|\vec{l}||\vec{B}|\sin(180) = 0$

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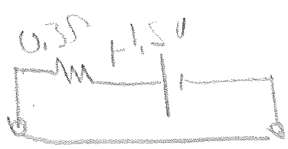
21) What is the maximum current that can be drawn from a 1.50-V battery that has an internal resistance of 0.30 ohms?

short it!

A) 2.5 A B) 5.0 A ✓ C) 0.45 A D) 4.5 A E) 0.20 A



$I = \frac{V}{R} = \frac{1.5}{0.3} = 5A$

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22) The voltage in a particular region of space is given by the function $V(x,y,z,t) = 7x^2y - 12z^3y + 4zt$. The units are SI. What is the $\hat{k}$ component of the corresponding electric field?

A) $-36yz^2 + 4$

B) $12yz^3 - 4zt$

C) $12y + 4t$

D) $36yz^2 - 4t$ ✓

$\vec{E} = -\nabla V$

$E_z = -\frac{\partial}{\partial z} V = -(-36z^2y + 4t) = \underline{+36z^2y - 4t}$