Physics 161 Fall 2011 Midterm Exam 3
10 Answer scantron. Last Name first.
Sit in odd # seats. Cell phones off. Closed Book.
Please keep your eyes on your own paper.
You may be photographed during this exam (by me) if you appear to be copying, using a cell phone, or otherwise cheating.
Equations

Sources of B

$\mu_0 = 4\pi \cdot 10^{-7}$ Tm/A

$\oint \vec{B} \cdot d\vec{l} = \mu_0 I_{enc}$

$\vec{B} = \frac{\mu_0}{4\pi} \frac{q\vec{v} \times \hat{r}}{r^2}$

$d\vec{B} = \frac{\mu_0}{4\pi} \frac{Id\vec{l} \times \hat{r}}{r^2}$

Responses to B

$\vec{F} = q\vec{v} \times \vec{B}$

$d\vec{F} = Id\vec{l} \times \vec{B}$

Torque on current loop:

$\vec{\tau} = \vec{\mu} \times \vec{B}$ $\quad \vec{\mu} = I\vec{A}$

Resistors and Circuits

$I = nqv_d A$

$\vec{J} = nq\vec{v}_d$

$V = IR$ Ohm's Law

$R = \frac{\rho L}{A}$ cylindrical resistor

$P = IV$

$P_R = I^2R = V^2/R$ power in a resistor

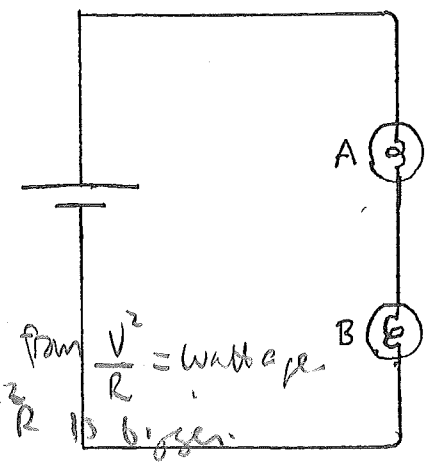
$R_{eq} = R_1 + R_2 + \ldots$ in series

$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$ in parallel

$q = C\mathcal{E}(1 - e^{-t/RC})$ charging

$q = q_0 e^{-t/RC}$ discharging

The power rating (wattage) on two low-voltage light bulbs is the power dissipated when 6V is applied. Assume that the brightness of a bulb is proportional to the power dissipated.



1. Two **identical** bulbs are wired as shown. The battery emf is 6V. Which bulb is brighter?
A] A B] B (C) they are the same.

2. Now instead, bulb A is a 1 W bulb and bulb B is a 4 W bulb. Which is brighter? (Choose answers from above.)
A is brighter. Find R from $\frac{V^2}{R}$ = wattage.
A has bigger R, so I^2R is bigger.

3. If either bulb will blow up if the voltage across it exceeds 6.4V, what is the highest voltage battery that can be used in this circuit? (to the nearest V, use 9 for 9 or greater.)

$R_A = \frac{36}{1} = 36\,\Omega$ $\quad V_A = \frac{36}{36+9} \cdot V_{batt}$

$R_B = \frac{36}{4} = 9\,\Omega$ $\quad = 6.4\,V$

$V_{batt} = 8\,V$

4. A resistor has the shape of a truncated cone. The small end has a diameter of 1 mm. The large end has a diameter of 2 mm. A current of 1 ampere flows through the resistor. What is the ratio of the electric field just inside the small end to the field just inside the large end? $\frac{E_{small}}{E_{large}} = \frac{A_{large}}{A_{small}} = 4$

(A] 4 B] 2 C] they are equal D] ½ E] ¼ F] Both fields are zero
G] Cannot determine without knowing the resistor length

5. In the circuit at right, what is the current through resistor R, to the nearest ampere?

$4 - 1 = 3A$

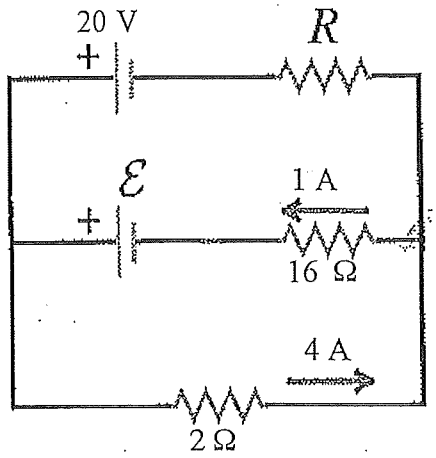
6. What is the resistance R, to the nearest ohm? (Use 9 for 9 or greater.)

$20V - 2\times4 - 3R = 0 \quad R = 4\,\Omega$

7. What is the magnitude of the unknown emf, to the nearest volt? (Use 9 for 9 or greater.)

$\mathcal{E} - 2\times4 - 1\times16 = 0 \quad \mathcal{E} = 24V$

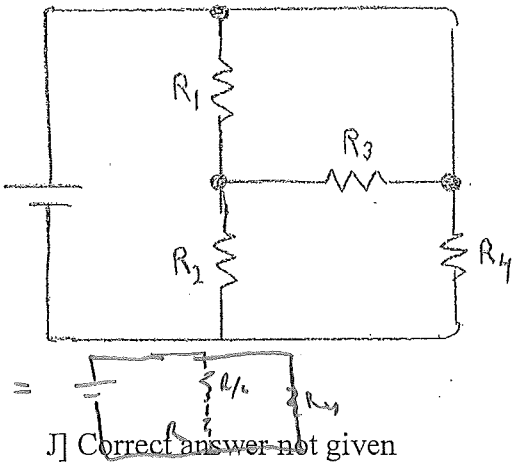
(9)



8. In the circuit shown, are any resistors **in series**?

A] R_1 & R_2 B] R_2 & R_3 C] R_3 & R_4
D] R_1 & R_3 E] R_1, R_3 & R_4 F] R_2 & R_4
G] Both R_1 & R_2 and R_3&R_4
H] Both R_1 & R_3 and R_2&R_4 (I] none

9. In the circuit shown, are any resistors **in parallel**? (choose from the answers to Q9) R_1 & R_3 (D]



10. If all resistors are the same, what fraction of the current from the battery flows through R_4 ?

A] ¼ B] 1/3 C] 2/5
D] ½ (E] 3/5 F] 2/3
G] ¾ H] 7/9 I] 0
J] Correct answer not given

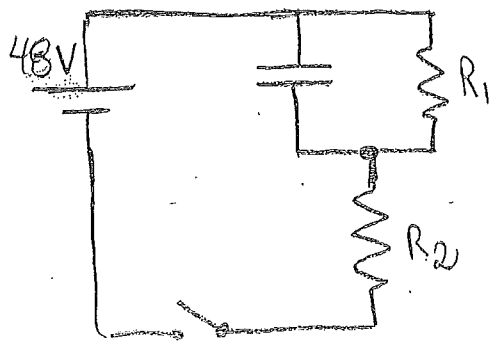
11. R_1 = 16 Ohms and R_2 = 8 Ohms. Immediately after closing the switch, what is the current through R_2, to the nearest ampere?

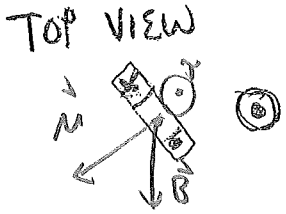
Replace Cap with wire. $I = 48V/8\Omega = 6A.$

12. A long time after closing the switch, what is the current through R_2, to the nearest ampere?

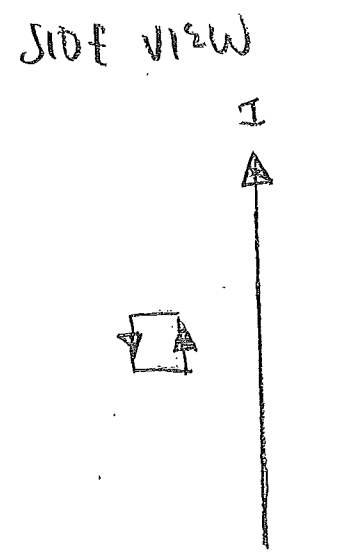
Replace Cap with open circuit

$I = 48V/(8+16)\Omega = 2A.$





13. A very long wire carries a current I, as shown at right.
A current loop is near the wire.
Is there a **net** torque or a **net** force on the current loop?
A] torque only B] force only
C] both D] neither

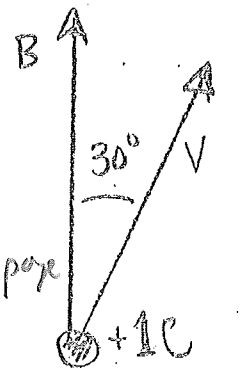


14. If there is a net torque, in what direction does it tend to rotate the loop as seen in the **top view**?
A] CW B] CCW
C] there is no torque

15. If there is a net force, in what direction does it push as seen in the **side view**?
A] right B] left C] up
D] down E] out of page F] into page
G] there is no net force

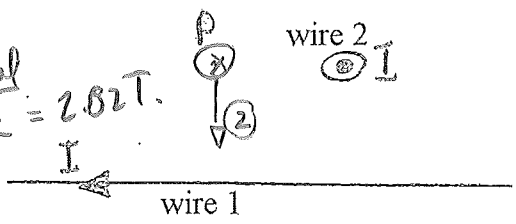
Attract Force on right wire > repulsion on left

16. A charge of +1 C is moving a 3 m/s in the direction shown. A uniform B field of 2 T exists throughout all space. What is the magnitude of the force on the charge (to the nearest N)? $qVxB = 1 \cdot 3 \cdot 2 \cdot \sin 30^\circ = 3\ N$



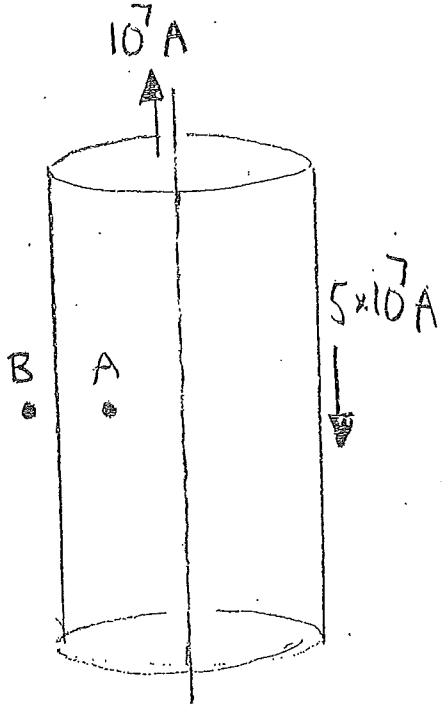
17. What is the trajectory of the charge?
A] a circle, above the page except at this point
B] a circle, below the page except at this point
C] a helix, mostly above the page, moving upward (along B) $\vec{V}x\vec{B}$ is out of page
D] a helix, mostly below the page, moving upward (along B)
E] a helix, mostly above the page, moving along v
F] a helix, mostly below the page, moving along v
G] a parabola, arcing down to the right
H] a parabola, arcing to the left

18. Two long wires are oriented as shown at right; each carries a current 10^7 A. What is the magnitude of the magnetic field at point P, 1 m from each wire (to the nearest T; use 9 for 9 or greater)?
$2\pi rB = \mu_0 I$ each wire; $B = 2\ T$ Total $= \sqrt{2}\,2 = 2.82\ T$.



19. Is there a force or torque on wire 2?
A] torque only B] force only
C] both D] neither

20. A long thin wire carries a current of 10^7 A upward. A concentric cylindrical shell carries a current of 5×10^7 A downward (uniformly distributed over the shell). What is the magnitude of the magnetic field at point A, 1 meter from the wire, inside the shell (to the nearest T, use 9 for 9 or greater)? $2\pi r B = \mu_0 I$ $B = 2$ T



21. What is the direction of the magnetic field at point A?
A] left (away from wire) B] right, toward wire
C] down D] up
E] into page (F) out of page
G] insufficient information

22. What is the magnitude of the magnetic field at point B, 2 m away from the wire, outside the shell (to the nearest T)?
$I_{enc} = 4 \times 10^7$ $B = 4$ T.

23. What is the direction of the magnetic field at B? Choose from the answers to Q21. E

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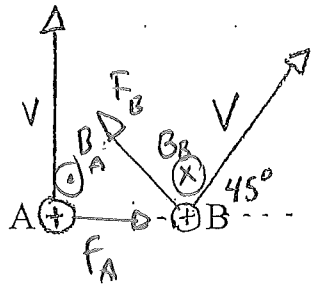
24. Two equal positive charges move with the same speed, but B is moving at 45° to the line between them, as shown. If the magnetic force on particle A is 1 N, what is the magnetic force on B, in N?
B: r is same, but $B_{on\ A}$ is weaker by $\sin\theta = 1/\sqrt{2}$. $F = qv \times B$

A] ¼ B] $1/(2\sqrt{2})$ C] ½ D] $1/\sqrt{2}$ E] 1
(F]$\sqrt{2}$) G] 2 H] $2\sqrt{2}$ I] 4 J] 0

25. What is the direction of the **magnetic** forces on these particles?
A] Directly away from each other
B] Directly towards each other
(C]) Force on A is towards B; Force on B is 45° up and left
D] Force on A is 45° down and right; Force on B is 45° up and left
E] Force on A is towards B; Force on B is 45° down and right
F] Force on both is out of the page
G] Force on A is out of the page; Force on B is into the page
H] Force on both is into the page
I] Force on A is down; Force on A is 45° up and left
J] Force on A is out of the page; there is no force on B.



26. Are the linear momentum and angular momentum of these two particles conserved?
A] yes, both are conserved
B] linear momentum is, but angular momentum is not
C] angular momentum is, but linear momentum is not
(D]) neither angular nor linear momentum is conserved