Physics 202 Midterm Exam 2  
October 25th, 2010

Name: ..............Yibin Pan...................... Student ID: ......................
Section: .............................

TA (please circle):
Matt Elbert  Josh Isaacs  Jianjia Fei  Hyungjun Lim  Zhen Liu
Frank McNally  Yongyan Rao  Xiao Wang  Michael Wood

Instructions:
1. Don’t forget to write down your name, student ID#, and section number.  You need do this on (this page of) your test book and on your Scantron sheet as well.

2. Answer all multiple choice questions in this test book by indicating the best answer among choices. You must do this both on your test book and on your Scantron sheet. Follow instructions on the Scantron sheet on how to mark valid answers.

3. When you finish, you need to turn in both this test book and the Scantron sheet.

4: Use the blank side of question pages as additional draft spaces. An extra blank sheet is provided at the end of the test book.

5: Only one answer is allowed per problem/question. All problems have equal weight.

Constants:  $e = 1.602 \times 10^{-19}$ C

Please be very careful with the first question even though the answer will not count towards your grade:

1. ENTER THE ID CODE ABOVE IN THE UPPER RIGHT CORNER
   A. ID Code A
   B. ID Code B
   C. ID Code C
   D. ID Code D
   E. ID Code E
2. Three capacitors, $C_1=6\mu F$, $C_2=3\mu F$ and $C_3=9\mu F$ are connected as shown.

![Capacitor Diagram]

The combined capacitance is:
A. 18 $\mu F$
B. 11 $\mu F$
C. 4.5 $\mu F$
D. None of above

\[ C_{12} = \frac{1}{C_1+\frac{1}{C_2}} = 2\mu F \]
\[ C_{123} = C_{12}+C_3 = 11\mu F \]

3. If a potential difference of 9V is applied on the above combination (i.e. $V_{AB}=9V$), how much is the charge on $C_1$?
A. 18 $\mu C$
B. 13 $\mu C$
C. 9 $\mu C$
D. None of above

\[ Q_1=Q_2=C_{12} \times V = 18\mu C \]

4. Still in the above configuration when 9V is applied across AB, what is the ratio of the energy stored in $C_1$ to that in $C_2$? (i.e. $U_1:U_2$)
A. 4:1
B. 1:4
C. 2:1
D. 1:2

\[ U=\frac{1}{2} Q^2/C \]
\[ Q_1=Q_2 \Rightarrow U_1:U_2=C_2:C_1 = 3:6=1:2 \]

5. Still in the above configuration when 9V is applied across AB, what is the ratio of the total energy stored in $C_1$ and $C_2$ to that in $C_3$? (i.e. $(U_1+U_2):U_3$)
A. 1:1
B. 1:9
C. 2:9
D. 9:2

\[ U=\frac{1}{2} CV^2 \]
\[ V_1+V_2=V_3 \Rightarrow U_{12}:U_3=C_{12}:C_3 = 2:9 \]
6. A 4Ω resistor has a current of 3.0 A running through it. How many electrons passing through this resistor during a time interval of 10s? (e = 1.6 \times 10^{-19} C)
   A. 30
   B. 120
   C. \(1.9 \times 10^{20}\)
   D. \(7.2 \times 10^{20}\)

\[
\Delta Q = I \Delta t = 30 \text{ C}
\]
\[
N = \frac{\Delta Q}{e} = 1.9 \times 10^{20}
\]

7. A copper wire of a uniform cross-section has a resistance of 10Ω. If the wire is cut in half in the middle. The resistance of each of the half-length wire is:
   A. 5Ω
   B. 10Ω
   C. 20Ω
   D. 40Ω

\[
R = \rho \frac{l}{A}, \quad l \rightarrow \frac{1}{2} l \quad \Rightarrow \quad R \rightarrow \frac{1}{2}R
\]

8. A bar magnet is to be cut at the dash-line as shown. (note the cut is not at the center).

Which of the following 4 cases represents the resulting configuration after cut?

A. NS S S
   B. NN S S
   C. NN N S
   D. NS N S

   Answer=D. Magnet always has two poles

9. The figure below shows the magnetic field lines near a bar magnet.

Which end is magnetic “North”?
   A. Left end
   B. Right end
   C. Can not be determined.

By definition.
10. In the circuit shown below, \( R_1 = 200 \Omega, R_2 = 80 \Omega, R_3 = 20 \Omega, R_4 = 70 \Omega \).

![Circuit Diagram]

The current through \( R_2, R_3, R_4 \), are found to be \( I_2 = 3A, I_3 = 8A, I_4 = 4A \), respectively in the directions indicated.

What is the current flown through \( R_1 \)?
A. 1A up
B. 1A down
C. 2.3A up
D. 2.3A down

11. In the above circuit, what is the \( \epsilon_2 \)?
A. 10V
B. 40V
C. 280V
D. 440V

12. Still in the above circuit, what is the power consumed on \( R_2 \)?
A. 240W
B. 560W
C. 720W
D. none of above

13. Still in the above circuit, what is the total power consumed?
(hint: batteries do not consume power)
A. 1150W
B. 2130W
C. 2780W
D. 3320W

Assign a direction for \( I_1 \) to be up
Apply junction rule at the “top junction”
\( I_1 + I_2 + I_4 = I_3 \) \( \rightarrow I_1 = 1A >0 \) \( \rightarrow \) so \( I_1 \) IS up

Practice: try assign \( I_1 \) to be down to start with.

Consider loop \( R_2 \epsilon_2 \epsilon_3 R_3 \) (clockwise):
Apply loop rule (given current direction as indicated)
\(-I_2 R_2 + \epsilon_2 + \epsilon_3 - I_3 R_3 = 0 \) \( \rightarrow \epsilon_2 = -360 + 3x80 + 8x20 = 40 \)

\( P_2 = I_2^2 R_2 = 3^2 \times 80 = 720W \)

Exercise: try \( I_2 \epsilon_2 + I_3 \epsilon_3 + I_4 \epsilon_4 \) and compare
What do you learn?
** The circuit below applies to the next four questions

In the circuit shown $R_1=1.0\,\text{k}\Omega$, $R_2=2.0\,\text{k}\Omega$, $C=30\,\mu\text{F}$. Initially switch $S$ is open and the capacitor holds a charge of $300\,\mu\text{C}$.

14. At $t=0$, $S$ is closed and $C$ starts to discharge. What is the time constant?
A. 10 ms  
B. 20 ms  
C. 90 ms  
D. none of above

R	ext{12}= 1/(1/R_1+1/R_2)=0.667\,\text{k}\Omega  
\tau=R_{12}C=20\text{ms}

15. At $t=0$, right after $S$ is closed, what is the current through $S$?
A. 5.0 mA  
B. 7.0 mA  
C. 9.0 mA  
D. 15 mA

I= Q/\tau =15\text{mA}  
(text formula 28.19 )

16. How long after $S$ is closed the charge on $C$ is reduced to $200\,\mu\text{C}$?
A. 4.3 ms  
B. 6.7 ms  
C. 8.1 ms  
D. 12.5 ms

Q(t)=Q_0e^{-t/\tau}  
\tau=-\ln(200/300)\tau=8.1\text{ms}

17. Still in the above process, between time $t=0$ and the moment when there is $200\,\mu\text{C}$ remaining on $C$, how much total energy is consumed on $R_1$ and $R_2$?
A. 0.67 mJ  
B. 0.83 mJ  
C. 1.5 mJ  
D. none of above or not enough information

Consider energy in the capacitor $U=1/2\,Q^2/C$

at $t=0$, $Q_0=300\,\mu\text{C}$, at a later $t$, $Q_1=200\,\mu\text{C}$

$\Delta U= \frac{1}{2} (Q_0^2-Q_1^2)/C=0.83\text{ mJ}$

Per energy conservation, that is the energy consumed.

You may use $P=I^2R$ and do an integration over time to get the same answer.
18. As shown, a charged particle of mass $m$ is moving counter-clockwise along a circular (and planar) path inside a uniform magnetic field $B$. The magnitude of the particle’s charge is $Q$. The particle has a linear speed of $v$.

Is the charge of the particle positive or negative?

A. positive
B. negative
C. Can not be determined with given information.

19. In the above setting, what is the angular speed of the particle’s circular motion?

A. $\frac{QB}{m}$
B. $2\pi \frac{QB}{m}$
C. $\frac{QB}{(mv)}$
D. none of above or can not be determined.

20. Still in the same setting, what is the magnitude of the magnetic force on the particle?

A. 0
B. $QvB$
C. $QvB\sin\theta$, where $\theta$ changes as the particle moves along the circle.
D. none of above.

21. Still in the same setting, during the period that the particle completes 10 full circles, what is the work done by the magnetic field to the particle?

A. 0
B. $10(\frac{1}{2} mv^2)$
C. $10QvB(2\pi r)$, where $r=\frac{mv}{(QB)}$ is the radius of the circle.
D. $10mv^2$