Physics 212 Test 2A

Chaps. 27 - 31

Dr. Gladden, April 5, 2012

NAME: KEY UM ID#:_____

Conceptual Multiple Choice (*2 points each*): Clearly write the letter corresponding to the BEST possible answer in the space provided. You may also circle the answer to be sure. **NOTE ON DIRECTIONS:** "North" is toward the top of the paper, "Up" is out of the paper. Constants: $\mu_0 = 4\pi \times 10^{-7}$ T m/A

1. D A charged particle moves and experiences no magnetic force. From this we can conclude that
   A) no magnetic field exists in that region of space.
   B) the particle is moving parallel to the magnetic field.
   C) the particle is moving at right angles to the magnetic field.
   D) either no magnetic field exists or the particle is moving parallel to the field.

2. C At double the distance from a long current-carrying wire, the strength of the magnetic field produced by that wire decreases to
   A) 1/8 of its original value.
   B) 1/4 of its original value.
   C) 1/2 of its original value.
   D) none of the given answers

3. A A conducting ring lays flat on a table. A bar magnet with the south end pointed downward approaches the ring from above. Looking down at the ring, the induced current will be flowing:
   A. clockwise
   B. counter clockwise
   C. up
   D. down

4. B For the same configuration described above, if the magnet were stationary and the area of the ring *decreased*, would the current be flowing:
   A. clockwise
   B. counter clockwise
   C. up
   D. down

5. A If the magnet above were moving away from the conducting ring, how would the area of the ring need to change in order to prevent any current from flowing?
   A. Increase
   B. Decrease
   C. Remain the same
   D. Rotate

6. A Kirchhoff's loop rule is an consequence of
A) conservation of energy.
B) conservation of charge.
C) conservation of momentum.
D) none of the given answers

7. B If a bar magnet is divided into two equal pieces,
A) the north and south poles are separated.
B) two magnets result.
C) the magnet properties are destroyed.
D) an electric field is created.

8. C Which of the following is correct?
A) When a current carrying wire is in your right hand, thumb in the direction of the magnetic field lines, your fingers point in the direction of the current.
B) When a current carrying wire is in your left hand, thumb in the direction of the magnetic field lines, your fingers point in the direction of the current.
C) When a current carrying wire is in your right hand, thumb in the direction of the current, your fingers point in the direction of the magnetic field lines.
D) When a current carrying wire is in your left hand, thumb in the direction of the current, your fingers point in the direction of the magnetic field lines.

9. A A vertical wire carries a current straight down. To the west of this wire, the magnetic field points
A) north.
B) east.
C) south.
D) down.

10. C A solenoid is connected to a galvanometer for which the direction of the needle deflection indicates the sign of the voltage. If a bar magnet passes all the way through the solenoid, describe the deflection of the needle.
A. Deflects one way, returns to 0, then deflects the same way.
B. Deflects one way, the slowly returns to 0.
C. Deflects one way, returns to 0, then deflects the other way.
D. Does not deflect at all.

11. A The force on a current-carrying wire in a magnetic field is equal to zero when
A) the current is parallel to the field lines.
B) the current is at a 30° angle with respect to the field lines.
C) the current is at a 60° angle with respect to the field lines.
D) the current is perpendicular to the field lines.

12. A The minimum magnitude of the torque on a current carrying loop occurs when the angle between the loop's magnetic moment and the magnetic field vector is
A) 0°
B) 90°
C) 180°
D) none of the given answers

13. C The direction of the force on a current-carrying wire in a magnetic field is described by which of the following?
A) perpendicular to the current only
B) perpendicular to the magnetic field only
C) perpendicular to both the current and the magnetic field
D) perpendicular to neither the current or the magnetic field

14. B Kirchhoff's junction rule is an consequence of
A) conservation of energy.
B) conservation of charge.
C) conservation of momentum.
D) none of the given answers

15. B When resistors are connected in parallel, we can be certain that
A) the same current flows in each one.
B) the potential difference across each is the same.
C) the power dissipated in each is the same.
D) their equivalent resistance is greater than the resistance of any one of the individual resistances.

16. B A charged particle moves across a constant magnetic field. The magnetic force on this particle
A) changes the particle's speed.
B) causes the particle to accelerate.
C) is in the direction of the particle's motion.
D) changes the particle's speed causing the particle to accelerate.

17. A An proton has an initial velocity to the north but is observed to curve upward as the result of a magnetic field. The direction of the magnetic field is
A) to the west.
B) to the east.
C) upward.
D) downward.

18. A A long straight wire carries current toward the east. A proton moves toward the east alongside and just south of the wire. What is the direction of the force on the proton?
A) north
B) south
C) up
D) down

19. D A velocity selector consists of a charged particle passing through crossed electric and magnetic fields. The forces exerted by these fields are in opposite directions, and only particles of a certain velocity will move in a straight line. In the following, disregard the magnitudes of the fields. In a velocity selector, the particles move toward the east, and the magnetic field is directed to the north. What direction should the electric field point?
A) east
B) west
C) up
D) down

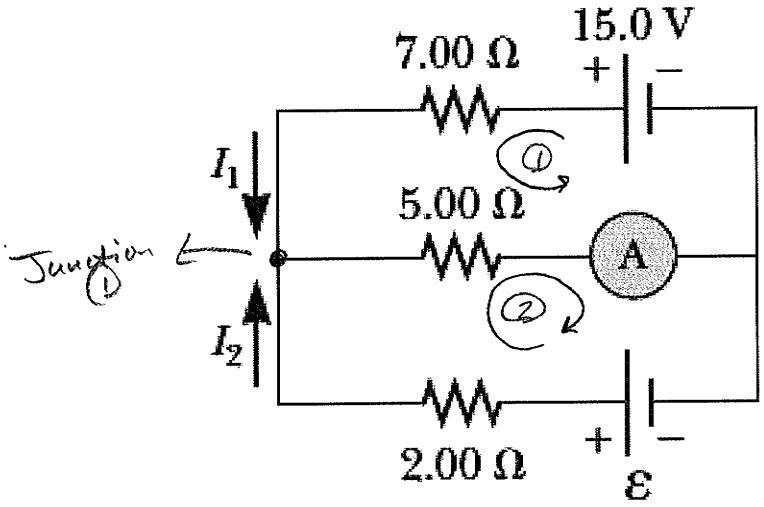
20. C Two small magnets are dropped from the same height. One passes through a coil of wire and one does not. The magnets reach the floor.
A. At the same time.
B. The one passing through the coil lands first.
C. The one passing through the coil lands last.
D. We need to know the polarity of the magnet as it enters the coil to answer this question.

Test B Key

1. D
2. A
3. A
4. C
5. A
6. C
7. A
8. A
9. C
10. B
11. B
12. B
13. A
14. B
15. A
16. A
17. B
18. C
19. D
20. C

Problems: Work each of the following problems. Make sure to **show your work** and put a box around your final answer. Each problem is worth 20 points total.

1. Consider the circuit shown below. The current measured by ammeter A is 1.25 Amps.



A. (*7 points*) Determine the current I_1.

Loop ① $+15 - I_1(7) - 1.25(5.0) = 0$

$\Rightarrow I_1 = \dfrac{15 - 6.25}{7} = 1.25\,A$

B. (*7 points*) Determine the current I_2.

Junction ①: $I_1 + I_2 = 1.25$

So $1.25 + I_2 = 1.25$

$\Rightarrow I_2 = 0$

B. (*6 points*) Determine the voltage $\mathcal{E}$ of the lower battery..

Loop ②: $+\mathcal{E} - I_2(2.0) - 1.25(5.0) = 0$

$I_2 = 0$ Since $I_2 = 0$

Thus $\mathcal{E} = 6.25\,V$

2. (*20 points*) A solenoid of length 10.0 cm and diameter of 3.0 cm with 300 loops of wire is connected to a 12 volt battery. The resistance of whole solenoid is 0.2 Ω.

A. (*4 points*) Compute the current passing through the solenoid.

Just use Ohm's Law: $V = IR$

$$I = \frac{V}{R} = \frac{12\,V}{0.2\,\Omega} = 60\,A$$

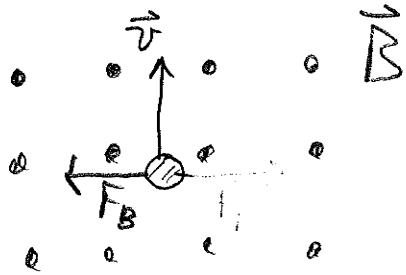
B. (*6 points*) Compute the magnetic field at the center of the solenoid (assume it has no material inside - a vacuum).

$|B|$ at Center of Solenoid is

$$B = \mu_0 \frac{N}{\ell} I = 4\pi \times 10^{-7}\,T\,m/A \left[\frac{300}{0.1\,m}\right][60\,A]$$

$$= 0.226\,T$$

C. (*10 points*) Assume the field at the end of the solenoid is the same as that at the center and the field there is pointing up. An electron moves at 1.5×10^5 m/s to the north. What is the *magnitude and direction* of the force on the electron as it passes by the end of the solenoid.



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

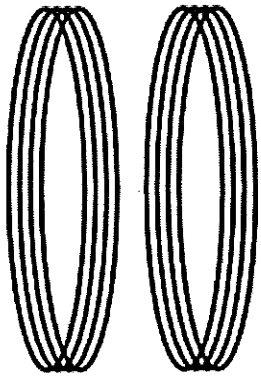
$$|F_B| = qvB\sin\theta, \quad \theta = 90^\circ \text{ so } \sin\theta = 1$$

$$= 1.6\times10^{-19}\,C\,[1.5\times10^5][0.226\,T]$$

$$= 5.4\times10^{-15}\,N \text{ West (to the left)}$$

↳ negative charge!

3. (*20 points*) Two identical coils each have 100 loops, area of 0.025 m^2, and are placed face to face as in the figure and no current is flowing in either coil. At $t = 0$, Coil 1 is connected to a voltage source that drives a linearly increasing voltage through it: $I_1(t) = 0.5(\text{Amps/sec})t$. At $t = 5$ seconds, I_1 is constant at 2.5 Amps.



Coil 1 Coil 2

$A = \pi r^2 = 0.025\ m^2$

$\Rightarrow r = 0.089\ m$

A. (*5 points*) Determine the flux through Coil 2 due to the magnetic field generated by Coil 1. (This will be time dependent).

$\Phi_B = BA\cos\theta$, $\theta = 0$ here so $\cos\theta = 1$

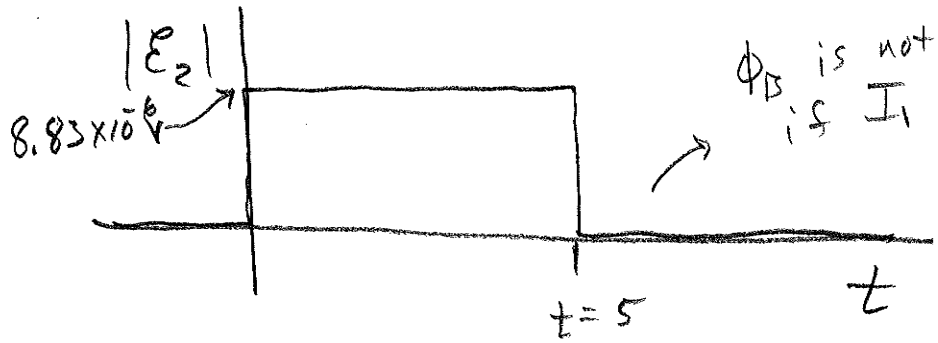
Need B at center of Coil 1 (and thus Coil 2). $B = N\frac{\mu_0 I}{2R} = \frac{100\,\mu_0[0.5t]}{2[0.089]}$

So $\boxed{\Phi_B = 8.83\times10^{-6}\,t}$

B. (*10 points*) Determine the induced EMF in Coil 2 ($\mathcal{E}_2$) between 0 and 5 seconds.

$\mathcal{E}_2 = -\frac{d\Phi_B}{dt} = -8.83\times10^{-6}\ V$

C. (*5 points*) Sketch a graph of $\mathcal{E}_2$ **between 0 and 10 seconds.**



Extra Credit (5 points)
Explain in your own words what the following equations means: $\mathcal{E} = -\frac{d\Phi_B}{dt}$

The induced EMF is equal to the rate at which the flux changes in a conducting loop. The direction of $\mathcal{E}$ is such to drive a current to oppose that change in flux.