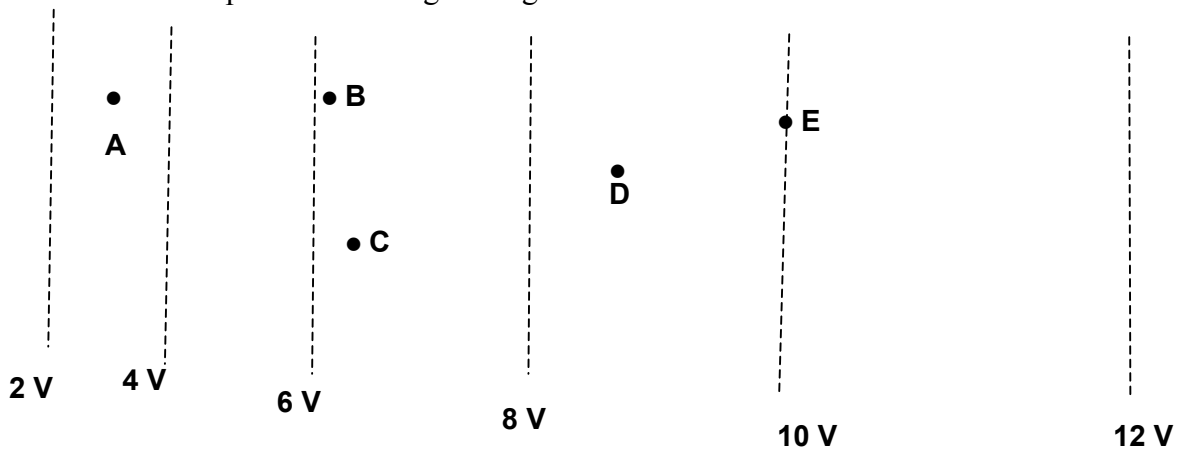
Physics 112
Exam #3
December 3, 1999

Put ALL of your answers on the Answer Sheet
#1-7 are NO PARTIAL CREDIT; 4 points each. If you want #5-7 graded out of 4.5 points (–1 [<u>minus one</u>] for wrong answer!!!) mark the indicated box on the Answer Sheet with an "X."
#8-#12 will get partial credit; points as shown on each one. NO EXTRA CREDIT OPTION on these problems. Show <u>ALL</u> answers on the Answer Sheet. NO ANSWERS WRITTEN ON QUESTION SHEET WILL BE CONSIDERED! TOTAL: 50 points.

1. Several equipotential lines are shown, with potential values indicated. Where should you place a proton so that it would experience the largest magnitude of acceleration?



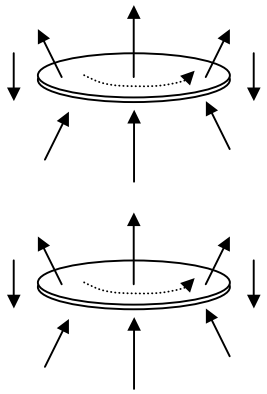
2. Suppose you take a 2-m long straight wire carrying a 3-A current into an otherwise empty room. You find that when the wire is aligned along the x axis there is ***no*** force on it, but there ***is*** a force on the wire when the wire is aligned along the y axis. Which of these could be true about ***this*** force?

   A. It points along the x axis because the magnetic field is along the x axis.
   B. It points along the x axis because the magnetic field is along the y axis.
   C. It points along the x axis because the magnetic field is along the z axis.
   D. It points along the z axis because the magnetic field is along the x axis.
   E. It points along the z axis because the magnetic field is along the y axis.
   F. It points along the z axis because the magnetic field is along the z axis.

3. What did British physicist James Clerk Maxwell discover in the 1860's that allowed him to predict the existence of electromagnetic waves?

   A. Unlike charges attract each other.
   B. Current-carrying conductors exert forces on each other.
   C. A changing magnetic field creates an electric field.
   D. A changing electric field creates a magnetic field (which then creates an electric field).
   E. The speed of visible light is 3×10^8 m/s.
   F. Electromagnetic waves are emitted by steady currents.

4.

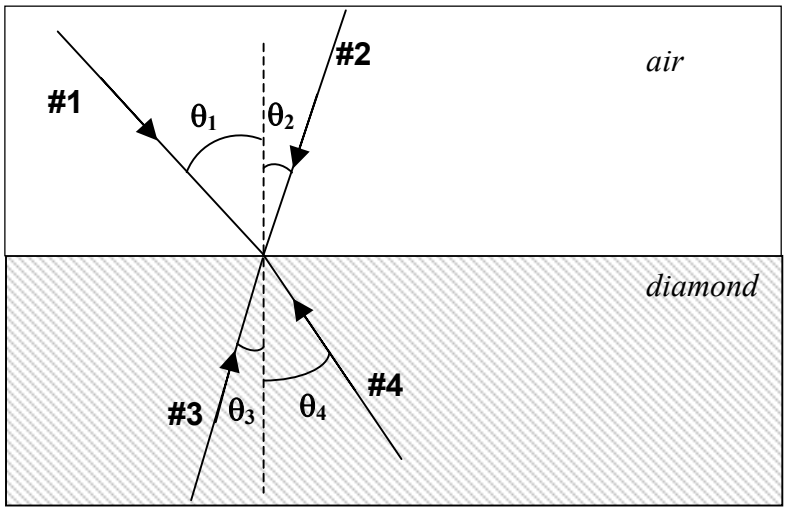


The diagram above shows two circular loops, one directly on top of the other, both carrying current in the same direction. Their magnetic fields are shown. There is ***no*** external magnetic field. What will happen to these loops?

A. They will attract each other.
B. They will repel each other.
C. They will twist in the same direction.
D. They will twist in opposite directions.
E. They will have no effect on each other.

5. The diagram shows four different light rays incident on an interface between air and diamond. The critical angle for diamond is 25° (index of refraction = 2.4 for diamond, 1.0 for air). Which of these light rays will be ***totally internally reflected?***

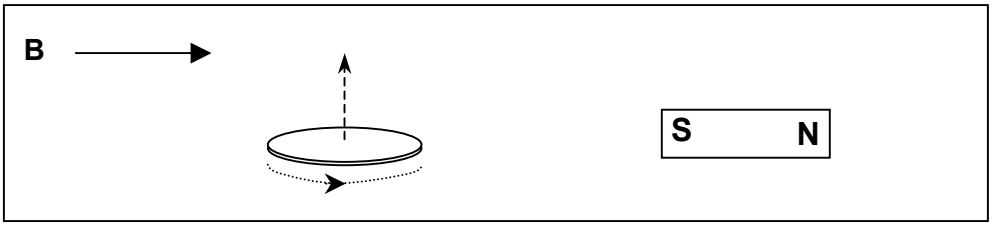
A. #1 only
B. #2 only
C. #3 only
D. #4 only
E. #2 and #3
F. #3 and #4
G. #1 and #2



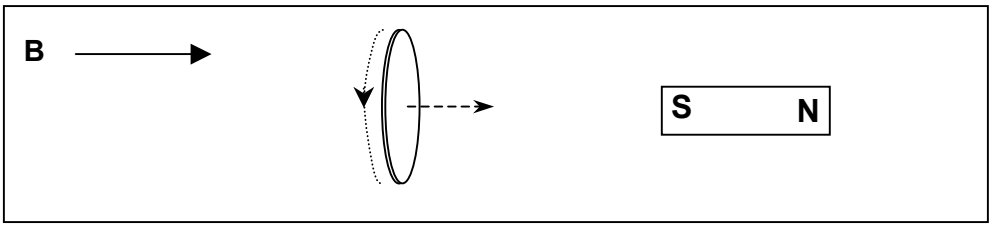
$\theta_1 = 42°$
$\theta_2 = 19°$
$\theta_3 = 16°$
$\theta_4 = 33°$

6. The region inside the box contains a uniform magnetic field as shown. Suppose the bar magnet and the current loop are placed in that region (far away from each other). Which diagram correctly shows how the loop and magnet will eventually align themselves inside that region? (The curved arrow on the loop shows direction of current flow, and the straight arrow is the normal to the plane of the loop.)

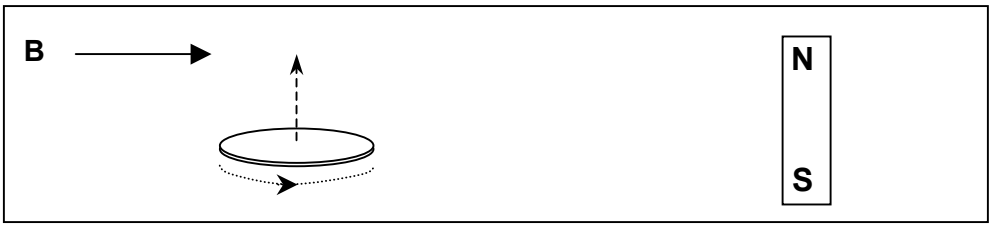
A.



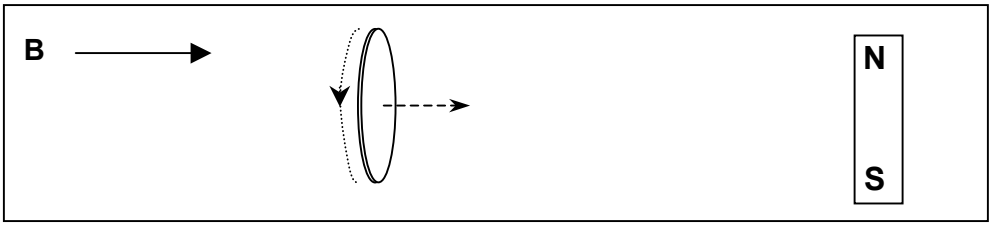
B.



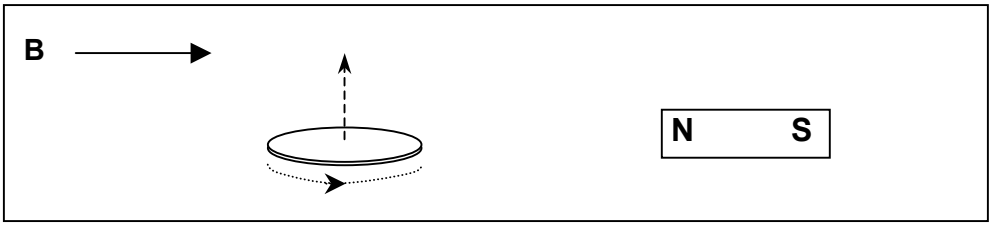
C.



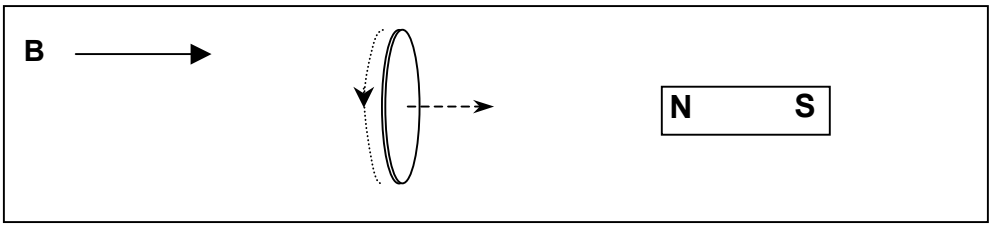
D.



E.



F.



7. When three identical resistors are connected in parallel to a particular battery, x amperes of current flow through the battery. If those same resistors are connected in series to the ***same*** battery, how much current will flow through the battery now?

A. $x/27$
B. $x/9$
C. $x/4$
D. $x/3$
E. $x/2$
F. x
G. $2x$
H. $3x$
I. $4x$
J. $9x$
K. $27x$

8. *[five points]* The bottom of this diagram shows a solenoidal coil connected to a battery through a switch; the switch is open at this moment so the circuit is not complete and there is no current flowing through the coil. Directly on top of the solenoid is a loop of wire. (The center of the loop is directly over the center of the coil.)

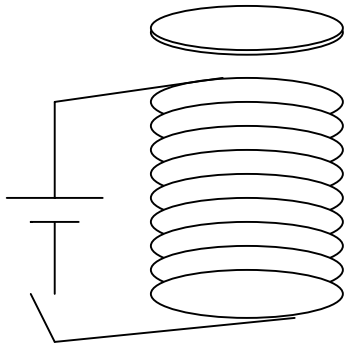
The diagram is shown at time t_1.

At exactly time t_2 the switch is closed so that current begins to flow through the coil. The switch ***remains closed*** so that current continues to flow through the coil.

Time t_3 occurs a few seconds after time t_2. (The switch is still closed at this time.)

Consider these four cases:

A. $I = 0, \Phi = 0$.
B. $I = 0, \Phi \neq 0$.
C. $I \neq 0, \Phi = 0$.
D. $I \neq 0, \Phi \neq 0$.



Which of these is true ***for the <u>loop</u>*** at:

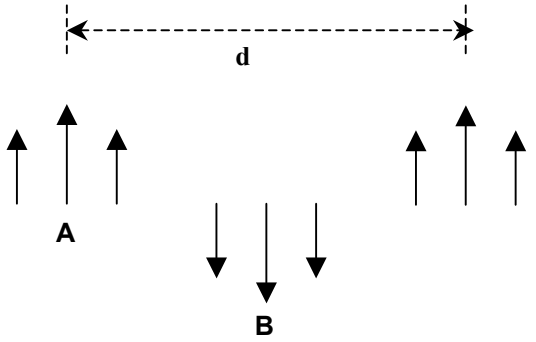
i) t_1 ?

ii) t_2 ?

iii) t_3 ?

9. *[four points]* A conducting loop is placed in a magnetic field; the direction of the magnetic field is constant, and the area and orientation of the loop also do not change. The magnitude of the magnetic field at different times is shown in the table on the answer sheet. The current in the loop at t = 1 s is shown. Fill in the current and current direction at t = 3 s and t = 5 s. (If no direction, write "none.")

10. *[five points]*



A snapshot of an electromagnetic wave at one moment in time is shown; the electric field vectors are represented. The distance *d* is 6 meters.

A) What is the period of this wave?

B) How long does it take to travel distance *d*?

C) Standing at one fixed location, you observe vector "A" at one moment in time. How long will it take until you next observe vector "B"?

11. *[four points]* An object made of glass is shown. ***Sketch*** a ray of light incident on the side marked "A" and continue to sketch its path as it travels ***through***, and then ***out*** of the object. (Do not choose an incidence angle of 0°.) Put arrows on your rays. Do not draw reflected rays, and assume there is no total internal reflection. You don't have to measure the angles, *but the relative magnitudes of the angles must be correct* (That is, it must be possible to rank the size of all relevant angles just by looking at your sketch.) Index of refraction for glass is 1.50. *Hint: It might be helpful to draw normals.*

12. *[four points]* The paths of two rays from the top of the object are shown. Draw the continuation of the other two paths indicated.

Physics 112
Exam #3 ANSWER SHEET
December 3, 1999

Name: _____

1. _____

2. _____

3. _____

4. _____

5. _____ ***Grade out of 4.5? Mark "X" here:*** _____

6. _____ ***Grade out of 4.5? Mark "X" here:*** _____

7. _____ ***Grade out of 4.5? Mark "X" here:*** _____

8. i) _____ ii) _____ iii) _____

9.

time (s)	magnetic field magnitude (T)	current in loop (A)	current direction
0	0	***[omit]***	[***omit]***
1	2	6 A	counterclockwise
2	4	***[omit]***	***[omit]***
3	4		
4	4	***[omit]***	***[omit]***
5	3		
6	2	***[omit]***	***[omit]***

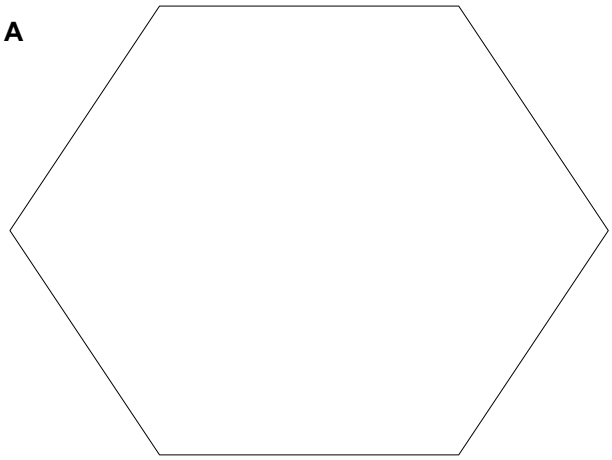
10.

A)

B)

C)

11.



12.