Physics 112
Exam #3
December 1, 2000

Put ALL of your answers on the Answer Sheet
#1-6 are NO PARTIAL CREDIT; 3 points each. If you want #1-6 graded out of 3.5 points (–1 [minus one] for wrong answer!!!) mark the indicated box on the Answer Sheet with an "X."
#7-#12 will get partial credit; points as shown on each one. NO EXTRA CREDIT OPTION on these problems. Show ALL answers on the Answer Sheet. NO ANSWERS WRITTEN ON QUESTION SHEET WILL BE CONSIDERED! TOTAL: 50 points.

1. Suppose you take a 3-m long straight wire carrying a 5-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 z axis. Which of these could be true about ***this*** force?

   A. It points along the y axis because the magnetic field is along the x axis.
   B. It points along the y axis because the magnetic field is along the y axis.
   C. It points along the y 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.

2. A loop of wire is placed in a magnetic field, and an ammeter is connected to the loop. Which type of field will result in the greatest deflection of the ammeter needle?

   A. perpendicular to the plane of the loop; magnitude initially at 0 T, decreasing at 0.01 T/s
   B. perpendicular to the plane of the loop; magnitude initially at 1 T, increasing at 0.001 T/s
   C. perpendicular to the plane of the loop; magnitude initially at 0.01 T, decreasing at 1 T/s
   D. perpendicular to the plane of the loop; magnitude constant at 100 T.
   E. 45° angle to the plane of the loop; magnitude initially at 10 T, decreasing at 0.1 T/s
   F. 45° angle to the plane of the loop; magnitude initially at 100 T, decreasing at 0.01 T/s
   G. parallel to the plane of the loop; magnitude initially at 1 T, increasing at 1 T/s
   H. parallel to the plane of the loop; magnitude initially at 100 T, decreasing at 10 T/s

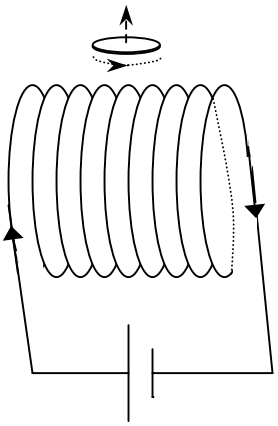
3. A wire carrying a current is brought next to a black box. The wire is attracted toward the box. Next, the wire is taken away, and a charged object is placed at rest next to the box. ***No*** push or pull is found to act on the charged object. The most likely explanation is:

   A. The black box contains a magnet and a charged object.
   B. The black box contains a magnet but no charged object.
   C. The black box contains a charged object but no magnet.
   D. The black box contains neither a magnet, nor a charged object.

4. Current flows out of a battery and into resistor A (2 ohms). When the current flows out of resistor A it branches, with part of it going through resistor B (2 ohms) and the rest going through resistor C (4 ohms). The current then recombines and returns to the battery. If the voltage drop across resistor A is ΔV_A, what is the voltage drop across resistor C?

A. 1/3 ΔV_A
B. ½ ΔV_A
C. 2/3 ΔV_A
D. ¾ ΔV_A
E. ΔV_A
F. 3/2 ΔV_A
G. 4/3 ΔV_A
H. 2 ΔV_A
I. 3 ΔV_A

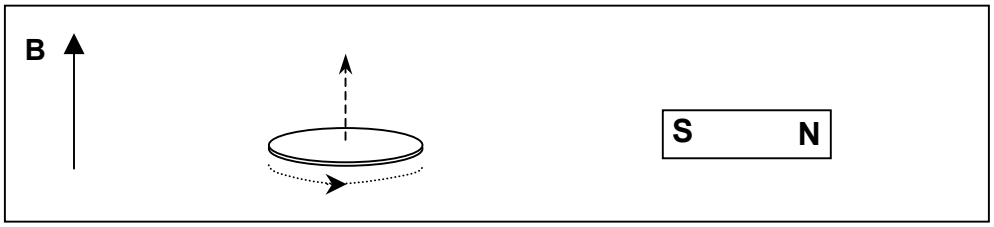
5. A current loop that is free to twist is placed directly above the middle of a solenoid. The solenoid is then hooked up to a battery which produces a current in the solenoid in the direction indicated by the arrows below. What is the final direction that the ***normal*** of the current loop (shown) will point? *Hint: Remember the similarity between the magnetic field of a bar magnet and that of a solenoid.*



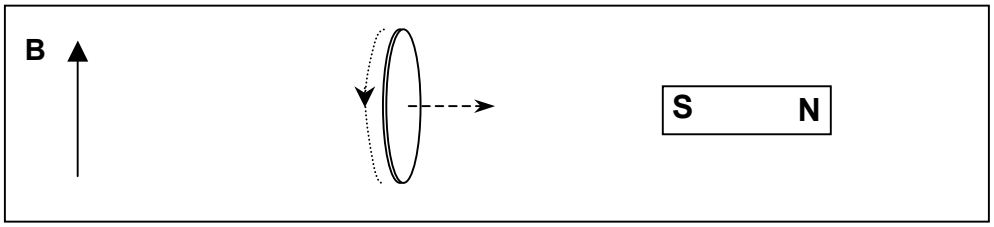
A. ↑
B. →
C. ←
D. ↓
E. ⊙
F. ⊗

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.)

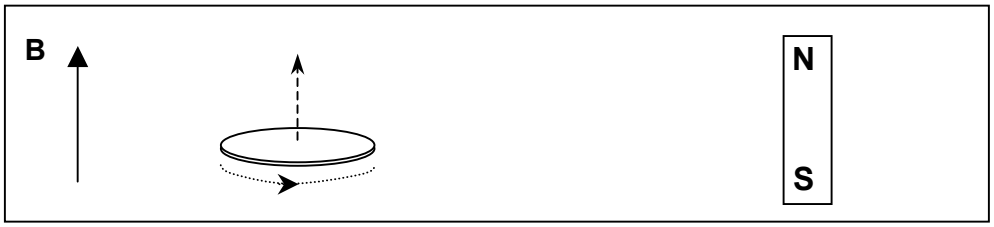
A.



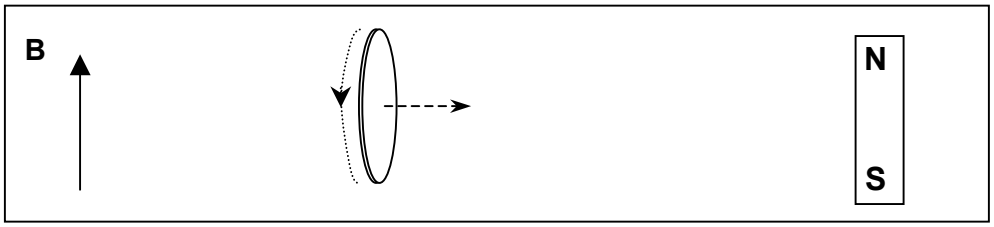
B.



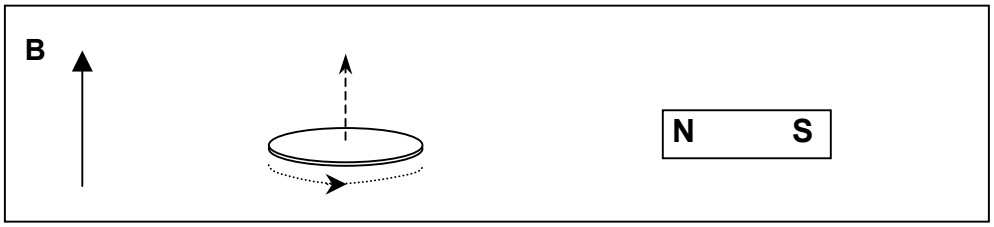
C.



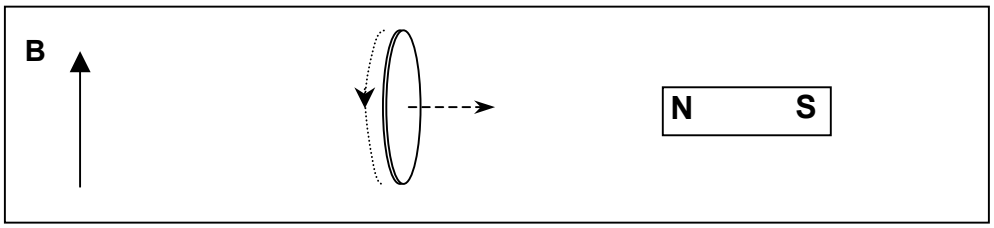
D.



E.



F.



7. *[4 points]*

A. a current loop in a uniform magnetic field may experience a net torque

B. a current loop in a non-uniform magnetic field may experience a net force

C. a changing magnetic flux induces a current to flow in a conducting loop

Choose the ***most appropriate*** explanation (A, B, or C) for the following:

i) An electric motor
ii) An electric generator
iii) A compass needle pointing north
iv) two magnets being attracted to each other

8. *[6 points]* You are standing motionless and observing an electromagnetic wave as it passes by your location. At time t = 0 s, you observe at your location the electric field vector shown on the answer sheet, and this is the ***maximum*** magnitude field that you observe. The frequency of this wave is 1000 Hz.

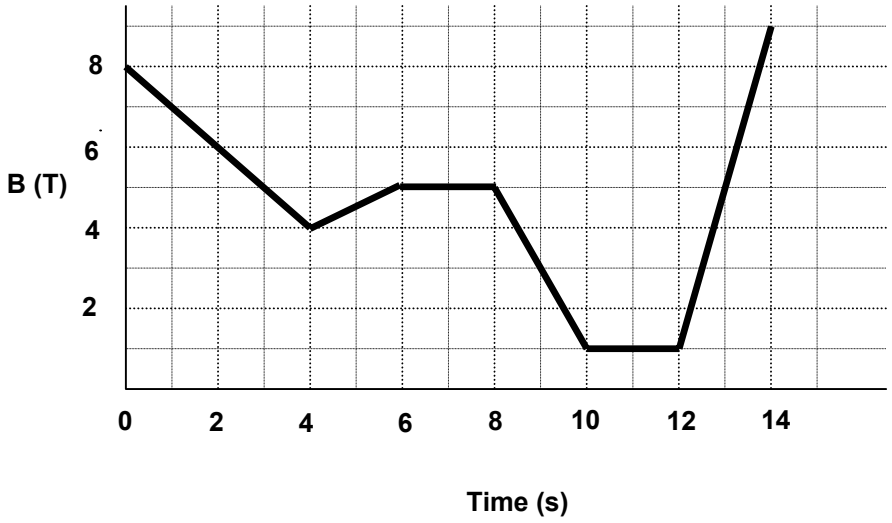
A. What is the wavelength of this wave?

B. Draw the electric field vector you will observe at your location at t = 0.001 s. (If zero, write "zero.")

C. Draw the electric field vector you will observe at your location at the moment the wave has traveled 1.5×10^5 m past its location at t = 0 s. (If zero, write "zero.")

9. *[5 points]* A +3.0 C charge is moving in the positive y direction with a constant velocity of 2 m/s. A uniform magnetic field **B** is then switched on. Immediately after the uniform magnetic field is switched on, the charge experiences a 30 N force and accelerates in the positive z direction. What is the direction *[2 pts]* and magnitude *[3 pts]* of the uniform magnetic field **B**? ***Note:*** *Assume that the direction of the magnetic field is one of the six choices listed.*

10. *[6 points]* A loop of wire is fixed in position in the presence of a magnetic field. The magnetic field has constant direction. The graph shows the magnitude of the magnetic field as a function of time. On the answer sheet, graph the current in the loop as a function of time***. Positive values mean "clockwise flow," negative values mean "counterclockwise flow."*** *The current flowing during 0 < t < 2 seconds is shown.*



11. *[5 points]* A piece of glass in the shape of a perfect hemisphere with a radius **R** is shown on the answer sheet. **Draw** a ray of light incident to the curved surface of the hemisphere. Complete the diagram by tracing the path of the light ray as it moves through and out of the piece of glass to emerge on the other side. 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 with respect to each other should be correct. Index of refraction for glass is 1.50, for air it is 1.00. *Hint: It might be helpful to draw normals. Remember that a line drawn from the center of curvature (the center of the sphere) to the surface of the sphere will be perpendicular to the surface.*

12. *[6 points]* On the answer sheet, the diagram on the left shows two isolated particles with equal magnitude charges, along with the electrical forces acting on those particles due to their mutual interactions.

    i. In the ***center*** diagram, reposition the charges so that they are separated from each other by ***half*** the distance that separated them in the diagram on the left. Represent the mutual interaction forces which will now be present.

    ii. In the diagram on the ***right***, the separation distance is the same as in the center diagram, but the charge on the ***left*** now has ***half*** its original magnitude. Again, draw the charges with the correct locations and forces indicated.

    iii. Explain your answers for (i) and (ii). *[Explanation is worth two out of the six points]*

Physics 112
Exam #3 ANSWER SHEET
December 1, 2000
Name: _____

1. _____ ***Grade out of 3.5? Mark "X" here:*** _____

2. _____ ***Grade out of 3.5? Mark "X" here:*** _____

3. _____ ***Grade out of 3.5? Mark "X" here:*** _____

4. _____ ***Grade out of 3.5? Mark "X" here:*** _____

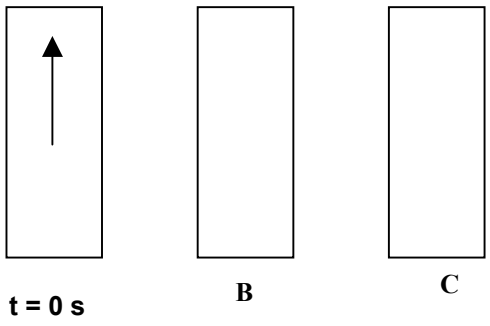
5. _____ ***Grade out of 3.5? Mark "X" here:*** _____

6. _____ ***Grade out of 3.5? Mark "X" here:*** _____

7. i) _____ ii) _____ iii) _____ iv) _____

8.

A. _____



9. Magnitude of **B**: _____

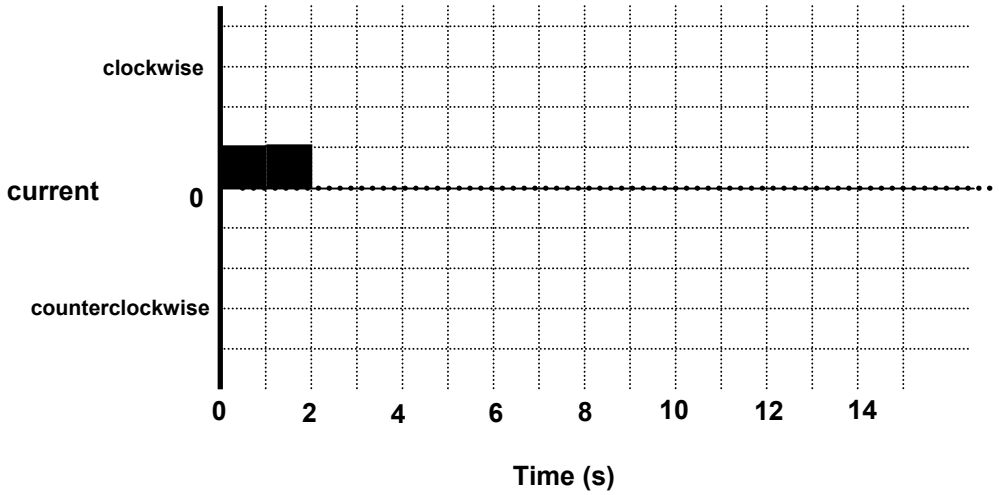
Direction of **B**: *(circle **one**)*

toward positive x toward negative x

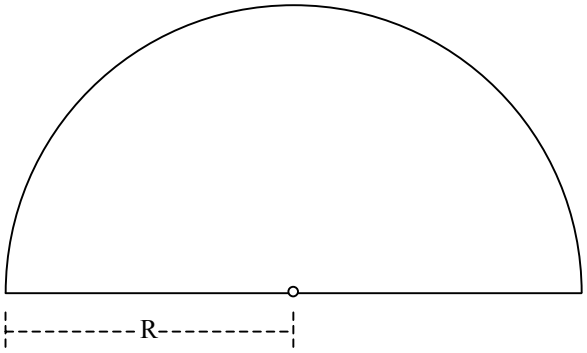
toward positive y toward negative y

toward positive z toward negative z

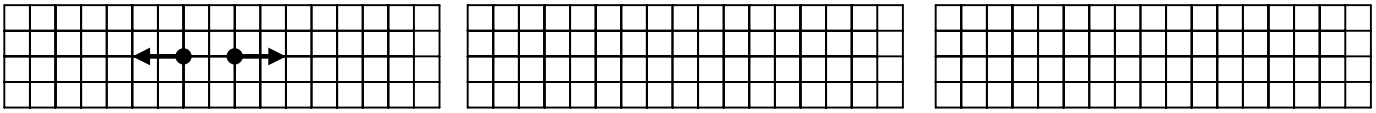
10.



11.



12.



Explanation: _____

_____

_____

_____