1. Suppose this page is perpendicular to a uniform magnetic field and the magnetic flux through it is 5Wb. If the page is turned by 30° around an edge the flux through it will be:
   A. 2.5Wb
   B. 4.3Wb
   C. 5Wb
   D. 5.8Wb
   E. 10Wb

2. A uniform magnetic field makes an angle of 30 degree with the z axis. If the magnetic flux through a 1-m² portion of the xy plane is 5Wb then the magnetic flux through a 2-m² portion of the same plane is:
   A. 2.5Wb
   B. 4.3Wb
   C. 5Wb
   D. 5.8Wb
   E. 10Wb

3. Faraday's law states that an induced emf is proportional to:
   A. the rate of change of the magnetic field
   B. the rate of change of the electric field
   C. the rate of change of the magnetic flux
   D. the rate of change of the electric flux
   E. zero
4. A square loop of wire lies in the plane of the page. A decreasing magnetic field is directed into the page. The induced current in the loop is:
A. counterclockwise
B. clockwise
C. zero
D. up the left edge and from right to left along the top edge
E. through the middle of the page

5. As an externally generated magnetic field through a certain conducting loop increases in magnitude, the field produced at points inside the loop by the current induced in the loop must be:
A. increasing in magnitude
B. decreasing in magnitude
C. in the same direction as the applied field
D. directed opposite to the applied field
E. perpendicular to the applied field

6. A long straight wire is in the plane of a rectangular conducting loop. The straight wire carries a constant current $i$, as shown. While the wire is being moved toward the rectangle the current in the rectangle is:

A. zero
B. clockwise
C. counterclockwise
D. clockwise in the left side and counterclockwise in the right side
E. counterclockwise in the left side and clockwise in the right side
7. A long straight wire is in the plane of a rectangular conducting loop. The straight wire carries an increasing current in the direction shown. The current in the rectangle is:

A. zero
B. clockwise
C. counterclockwise
D. clockwise in the left side and counterclockwise in the right side
E. counterclockwise in the left side and clockwise in the right side

8. A long straight wire is in the plane of a rectangular conducting loop. The straight wire initially carries a constant current $i$ in the direction shown. While the current $i$ is being shut off, the current in the rectangle is:

A. zero
B. clockwise
C. counterclockwise
D. clockwise in the left side and counterclockwise in the right side
E. counterclockwise in the left side and clockwise in the right side
9. A rectangular loop of wire is placed midway between two long straight parallel conductors as shown. The conductors carry currents $i_1$ and $i_2$, as indicated. If $i_1$ is increasing and $i_2$ is constant, then the induced current in the loop is:

A. zero  
B. clockwise  
C. counterclockwise  
D. depends on $i_1 - i_2$  
E. depends on $i_1 + i_2$

10. One hundred turns of insulated copper wire are wrapped around an iron core of cross-sectional area 0.100 m$^2$. The circuit is completed by connecting the coil to a 10-$\Omega$ resistor. As the magnetic field along the coil axis changes from 1.00T in one direction to 1.00T in the other direction, the total charge that flows through the resistor is:

A. $10^{-2}$ C  
B. $2 \times 10^{-2}$ C  
C. 1 C  
D. 2 C  
E. 0.20 C
11. A magnet moves inside a coil. Consider the following factors:
I. strength of the magnet
II. number of turns in the coil
III. speed at which the magnet moves
Which can affect the emf induced in the coil?
A. I only
B. II only
C. III only
D. I and II only
E. I, II, III

12. The circuit shown is in a uniform magnetic field that is into the page. The current in the circuit is 0.20 A. At what rate is the magnitude of the magnetic field changing? Is it increasing or decreasing?:

A. zero
B. 140T/s, decreasing
C. 140T/s, increasing
D. 420T/s, decreasing
E. 420T/s, increasing
13. A changing magnetic field pierces the interior of a circuit containing three identical resistors. Two voltmeters are connected to the same points, as shown. $V_1$ reads 1mV. $V_2$ reads:

A. 0  
B. $1/3$mV  
C. $1/2$mV  
D. 1mV  
E. 2mV

14. A circular loop of wire is positioned half in and half out of a square region of constant uniform magnetic field directed into the page, as shown. To induce a clockwise current in this loop:

A. move it in $+x$ direction  
B. move it in $+y$ direction  
C. move it in $-y$ direction  
D. move it in $-x$ direction  
E. increase the strength of the magnetic field
15. The four wire loops shown have edge lengths of either \( L \), \( 2L \), or \( 3L \). They will move with the same speed into a region of uniform magnetic field \( \vec{B} \), directed out of the page. Rank them according to the maximum magnitude of the induced emf, least to greatest.

A. 1 and 2 tie, then 3 and 4 tie
B. 3 and 4 tie, then 1 and 2 tie
C. 4, 2, 3, 1
D. 1, then 2 and 3 tie, then 4
E. 1, 2, 3, 4

16. The figure shows a bar moving to the right on two conducting rails. To make an induced current \( i \) in the direction indicated, a constant magnetic field in region \( A \) should be in what direction?

A. Right
B. Left
C. Into the page
D. Out of the page
E. Impossible; this cannot be done with a constant magnetic field
17. A car travels northward at 75km/h along a straight road in a region where Earth’s magnetic field has a vertical component of 0.50 \times 10^{-4} \text{T}. The emf induced between the left and right side, separated by 1.7m, is:
A. 0
B. 1.8mV
C. 3.6mV
D. 6.4mV
E. 13mV

18. A rod lies across frictionless rails in a constant uniform magnetic field $B$, as shown. The rod moves to the right with speed $v$. In order for the emf around the circuit to be zero, the magnitude of the magnetic field should:

A. not change
B. increase linearly with time
C. decrease linearly with time
D. increase quadratically with time
E. decrease quadratically with time
SHOW ALL WORK (5 points)

A solenoid having an inductance of 6.30 µH is connected in series with a 1.20 kΩ resistor. (a) If a 14.0 V battery is connected across the pair, how long will it take for the current through the resistor to reach 80% of its final value? (b) What is the current through the resistor at time \( t = \tau_L \)?