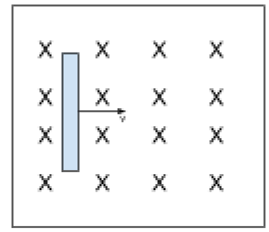
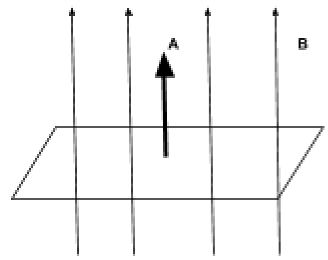
Magnetic Flux

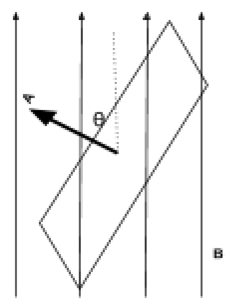
1. A straight conducting bar is moving in a magnetic field as shown.
    a. Explain what would happen to the charges in the bar.
    b. Describe why the voltage difference between the ends of the bar are related to the speed of the bar.



2. The *magnetic flux* through a bound region is given by the equation $\Phi = A \bullet B = AB\cos\theta$ where ***A*** is the area vector and ***B*** is the magnetic field vector. The dot product is a way to multiply parallel parts (components that are pointing in the same direction) of vectors. θ is the angle between the area vector and the magnetic field vector.

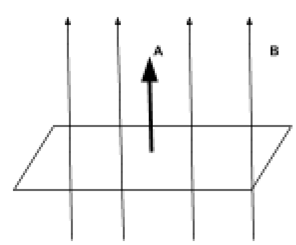


    a. Describe what happens to the magnetic flux through a loop as the loop is rotated as shown in the diagram to the right until θ=90 degrees.
    b. Describe a different way to decrease the magnetic flux without rotating the coil of wire.
    c. Describe a way to increase the magnetic flux.

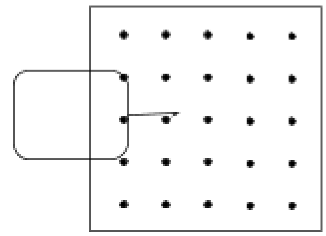


3. A circular loop of wire has a radius of 5.0 cm and is placed on the plane of the page. There is a 3.0×10^{-3} T magnetic field pointed directly out of the page.
    a. Draw a diagram of the arrangement.
    b. Calculate the magnetic flux.
    c. The magnetic field increases to 4.0×10^{-3} T. Calculate the new magnetic flux.
    d. The loop is now rotated until the area vector makes a 30° angle to the field. Calculate the new magnetic flux.

4. **Lenz's Law**: The induced current in a loop is in a direction to create a magnetic field that is parallel to and in the opposite direction of the **change** in the magnetic flux through the bounded area.



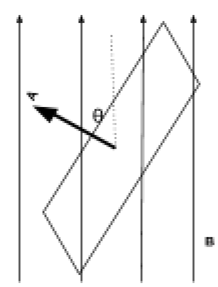
    A square wire is in a magnetic field as shown on the right.
    a. If the magnetic field increases, what direction would the current flow in the wire?
    b. If the magnetic field decreases, what direction would the current flow in the wire?



5. A magnetic field is contained in a region as shown in the diagram. A single wire loop is pulled to the right. Describe the current in the wire as it moves at a constant speed:
    a. into the magnetic field.
    b. through the magnetic field.
    c. out of the magnetic field.

6. Magnetic flux linkage: The magnetic flux linkage is equal to the magnetic flux through one loop times the number of loops.
    A solenoid contains 50 circular turns with a radius of 4.0 cm. The magnetic field is parallel to the axis of the solenoid with a strength of 7 mT. Calculate the magnetic flux linkage of the arrangement.

7. **Faraday's Law:** The EMF (ε) induced when the magnetic flux changes is described by the equation $\varepsilon = -N\frac{\Delta\Phi}{\Delta t}$ where N is the number of turns of the wire. The negative sign is the result of Lenz's Law.
    A single circular loop of wire has a radius of 10.0 cm. The magnetic field is parallel to the loop's area vector and is increasing at 0.16 T s^{-1}. Calculate the ε induced in the loop.



8. A 50 loop square wire with 5.0 cm sides is placed in a 6.0 mT magnetic field. The wire has a resistance of 20 Ω.
    a. Calculate the magnetic flux linkage when the loops are oriented 15° to the field.
    b. If you measure the current in the wire to be 8.0 mA at one instant, calculate the rate at which the magnetic flux linkage is changing.
    c. The loop is rotating at a constant angular speed. This means the rate at which the magnetic flux linkage is changing is given by some constant values (we can discuss these if you are interested) times $\sin\theta$. Sketch the graph of the EMF induced vs angle for the angles 0 to 90°.