EM Induction Review

3.2 Electromagnetic Induction

Be able to:

- identify the contributions of Faraday, Oersted, Lenz, etc.
- describe the causes of induced emf
- solve problems involving motional emf
- solve problems involving magnetic flux
- apply Faraday's law to determine the emf induced in a coil of wire
- apply Lenz's law to determine the direction of an induced current
- describe the emf of a rotating loop of wire
- describe the function of an ac generator
- recognize the graph of voltage versus time for the ac cycle
- solve problems involving transformers
- describe energy production in Manitoba

Review Problems

1. A flat bed truck travels due south at 120 km/h in a location where the vertical component of the earth's magnetic field is $5\times10^{-6}\ T$. What is the emf induced in a 1.0 m long copper bar held horizontally above the bed of the truck and perpendicular to the direction of motion? ($0.17\ mV$)

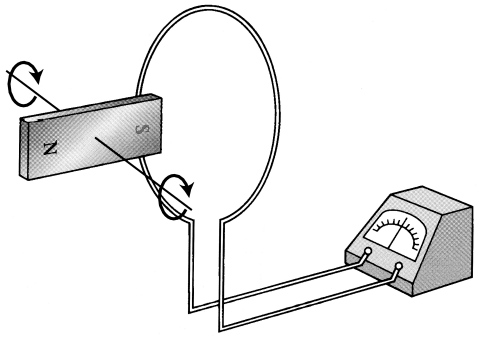
2. What emf is developed between the tips of the wings of a Boeing 767 jet liner in level flight at 850 km/h in a location where the vertical component of the earth's magnetic field is $1.75\times10^{-5}\ T$? The distance between the wing tips of the 767 is $47.65\ m$. ($0.20\ V$)

3. A 1.0 m long aluminum bar is held horizontally in the east-west direction and dropped from a height of 10 m at a place where the horizontal component of the earth's magnetic field is $3.8\times10^{-5}\ T$. What is the emf between the ends of the bar just before it strikes the ground? ($0.53\ mV$)

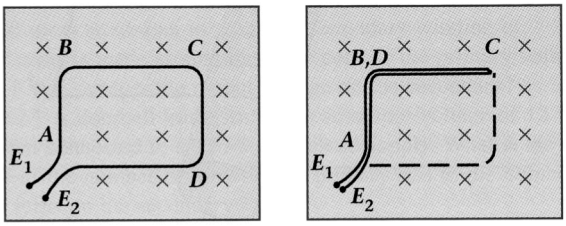
4. A coil contains 100 turns of wire in a loop 15 cm in diameter. The loop is placed between the poles of a large electromagnet, $B=1.0\ T$, with the plane of the loop perpendicular to the field. If the magnetic field is steadily reduced from $1.0\ T$ to 0 in 16 s, what is the average emf in the coil while the field is changing? ($0.11\ V$)

5. The flux in a single-loop coil of area $37\ cm^2$ steadily changes from $6.5\times10^{-3}\ T$ to $9.3\times10^{-3}\ T$ in 0.50 s. What emf is induced in the coil? ($21\ \mu V$)

6. A bar magnet is rotated at a steady rate about its center as shown below. Describe the effect this will have on a loop of wire located nearby. Sketch a graph of the voltage output of the loop as a function of time.



7. The plane of a square loop of wire with edge length of 8.0 cm is perpendicular to a 0.017 T magnetic field as shown below. What is the average emf between the points E_1 and E_2 when the corner D is quickly folded about the diagonal AC so as to lie on top of B if it takes 0.13 s to make the fold? ($8.4\times10^{-4}\ V$)

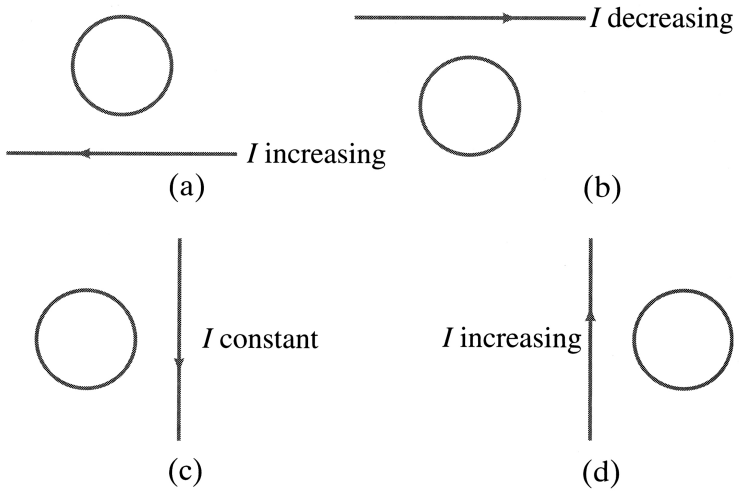


8. A 10 turn square coil with 12 cm long sides is held in a uniform magnetic field of 0.090 T. The normal to the plane of the coil makes an angle of 43° with the direction of the field. The coil is withdrawn to a region of zero field in 0.17 s. What is the average emf developed in the coil as it is withdrawn from the field? (0.056 V)

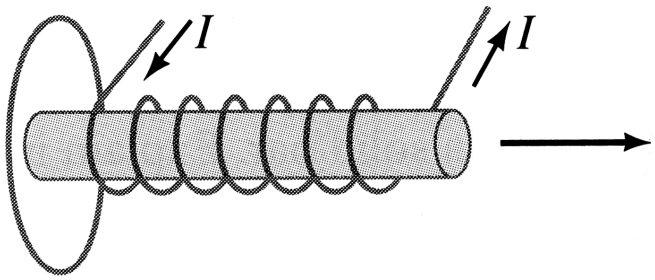
9. A 2.8 cm radius, 50 turn coil of 12.5 Ω resistance rotates about a diameter in a uniform magnetic field of 0.090 T. The coil starts with the normal to its plane parallel to the direction of the field and ends with the normal perpendicular to the direction of the field. If an instrument to measure electric charge is connected to the coil, how much charge would it record when the coil is flipped? (8.9×10^{-4} C)

10. A "flip coil" of 50 mm radius and 50 turns is oriented perpendicular to a magnetic field. the coil is quickly flipped through 180° about its diameter in 0.070 s. The average emf in the coil is measured to be 2.0 V. What is the strength of the magnetic field in the region of the coil? (0.18 T)

11. What is the direction of the induced current in the circular loop due to the current shown in each part of the diagram below?



12. If the solenoid in the diagram below is being pulled away from the loop shown, in what direction is the induced current in the part of the loop closest to the viewer?



13. A transformer is made by winding a primary coil of 300 turns around an iron core. A secondary winding of 750 turns is made about the same core. If the primary voltage is 120 V, what is the output voltage on the secondary? (300 V)

14. A transformer is made by winding a primary coil of 250 turns around an iron core. A secondary winding of 50 turns is made around the same iron core. If the primary voltage is 120 V, what is the output voltage on the secondary? (24 V)

15. A doorbell transformer has an output voltage of 12 V when connected to a 120 V household supply. What is the ratio of the number of turns on the primary coil to the number of turns on the secondary coil? (10/1)

16. A step-down transformer that converts 120 V ac to 10 V ac is rated for 1.5 A output current on the secondary winding. What is the input current when the output is 1.5 A? (0.125 A)

17. A transformer attached to a 138 kV transmission line has an output voltage of 38 kV. What is the ratio of the number of turns on the primary coil to the number of turns on the secondary coil? (3.6/1)

18. A potential difference of 120 V is maintained across the primary coil of a transformer. The secondary coil is connected to a circuit that has a total resistance of 6.42 Ω and dissipates 22.5 W. What is the ratio of the number of turns on the primary to the number of turns on the secondary? (10/1)